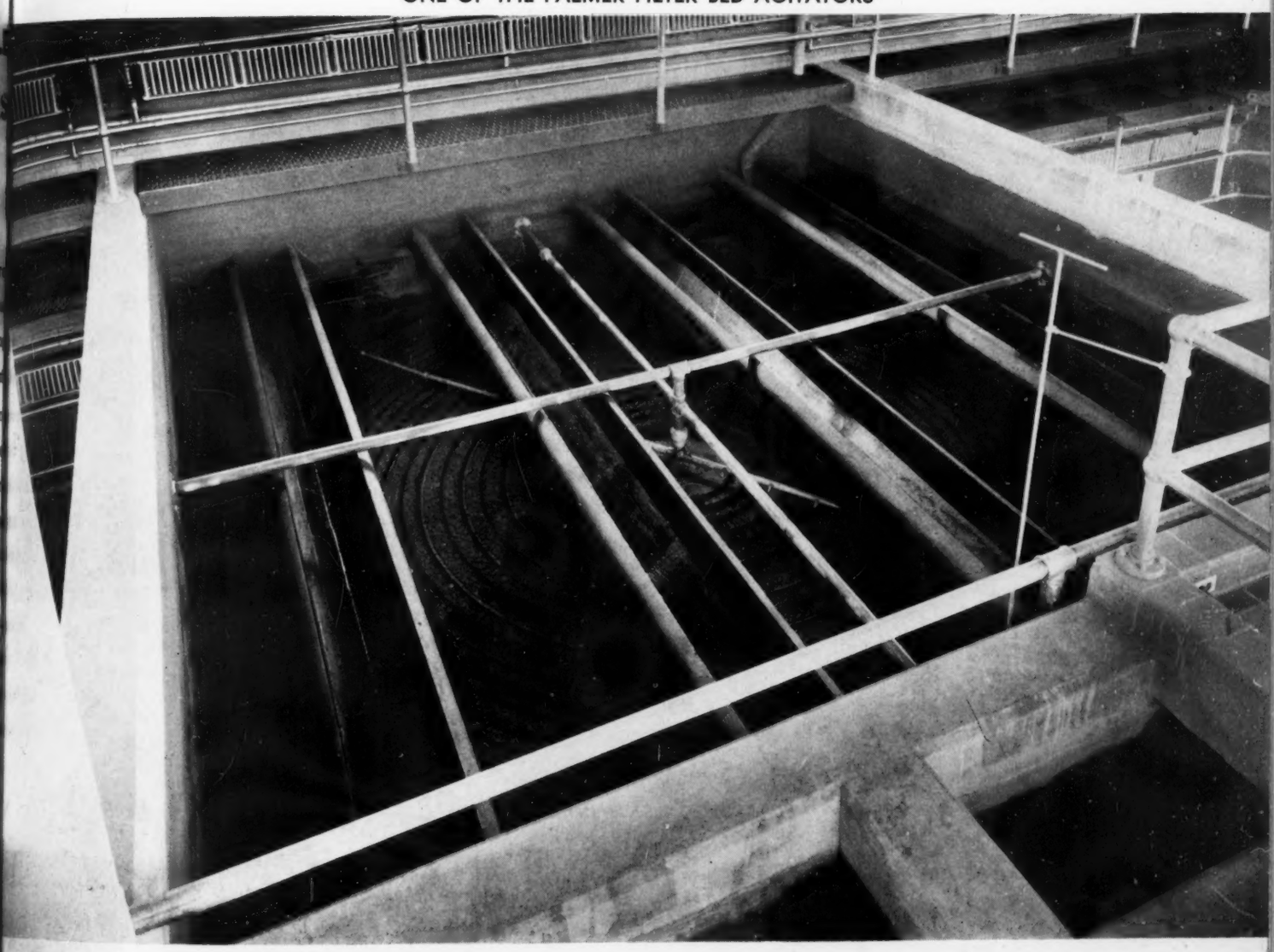
WATER WORKS & SEWERAGE

AT ALLENTOWN, PA.
ONE OF THE PALMER FILTER BED AGITATORS

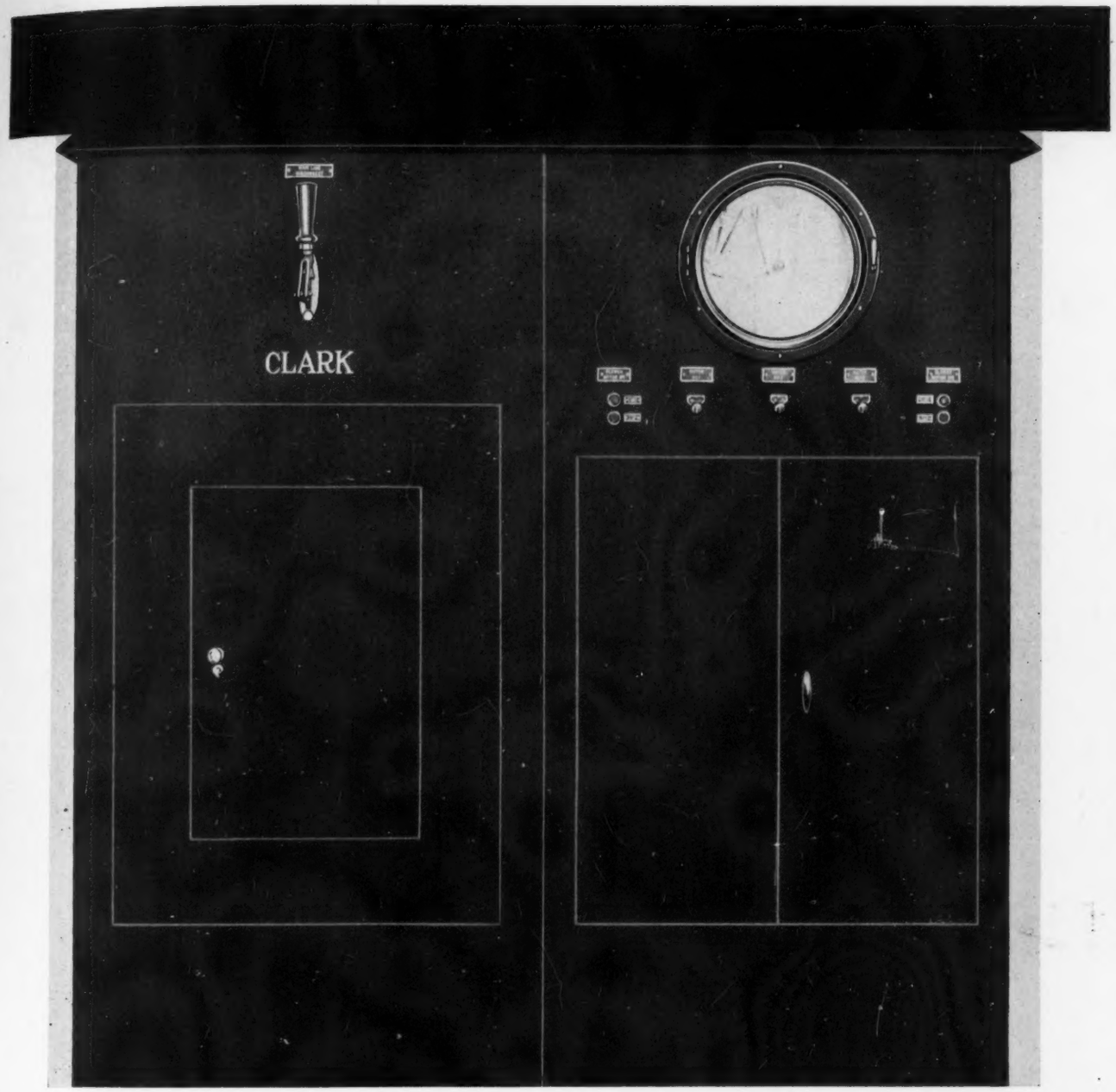


A SPADE is one of the oldest tools known to man and still very handy when it comes to leveling off the bottom of a trench. But trench hoes and bulldozers have largely displaced the spade in the construction of cast iron pipe lines. Cast iron pipe is likewise one of the oldest materials for underground mains. Yet, in three centuries, no other type of pipe has usurped its place as the *standard* material for underground mains. Super-de Lavaud centrifugally cast iron pipe is the same standard material produced by improved and carefully controlled casting methods.

U. S. PIPE & FOUNDRY CO.
General Offices: Burlington, N. J.
Plants and Sales Offices Throughout the U. S. A.

U.S. cast iron PIPE

Centrifugally or Pit Cast for water works, gas, sewerage, drainage and industrial services.



● Each section of this dead-front sewage treatment plant control cabinet was built to pass through a 36" manhole.

As these cabinets were erected underground, a special hood, to carry off any possible condensation, was placed over both sections.

With doors closed, the entire front is dead; with doors opened, all electrical control apparatus is easily accessible.

3-10 HP Sewage Pump Motors, and 2-⅓ HP Blower Motors are controlled and protected by "3C" apparatus.

These cabinets are just another illustration of how Clark engineering and apparatus solve difficult electrical control problems.

Our nearest office will gladly consult with you.

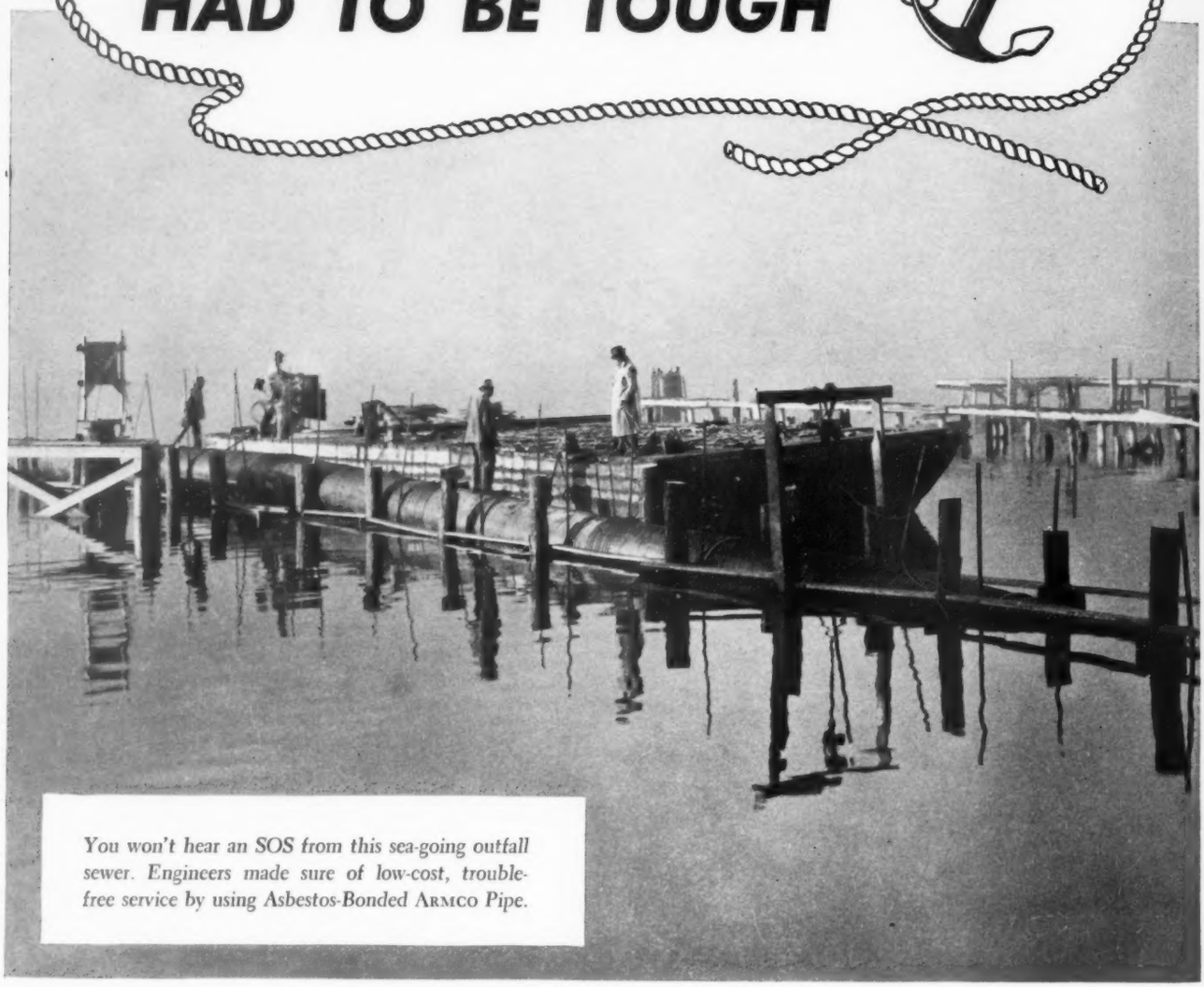
OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

WATER WORKS & SEWERAGE, May, 1941. Volume 88. Number 5. Published monthly at 330 South Wells Street, Chicago, Ill., by the Gillette Publishing Company. Per copy, 25c. Subscription rate, United States $2.00 per year; Canada $2.40 per year; Foreign $3.00 per year. Copyright, 1941. Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under Act of March 3, 1879.

This SEA-GOING SEWER *HAD TO BE TOUGH*



You won't hear an SOS from this sea-going outfall sewer. Engineers made sure of low-cost, trouble-free service by using Asbestos-Bonded ARMCO *Pipe.*

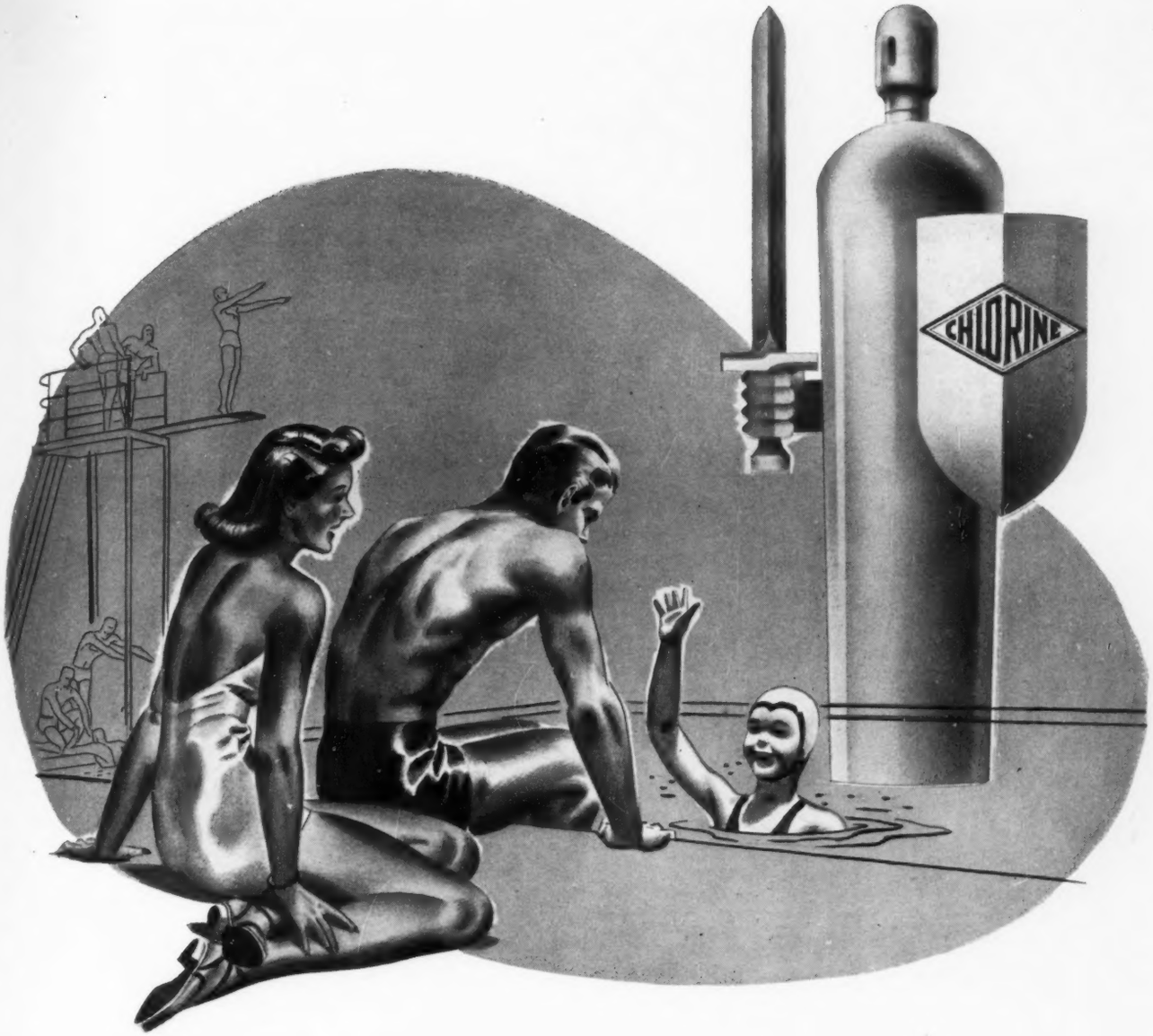
Davy Jones' locker is no place for a "landlubbing" sewer. Unstable foundations and corrosive conditions are a severe test for any pipe. Yet Asbestos-Bonded ARMCO Sewer Pipe makes the grade here with something to spare.

Extra strength and durability are built into Asbestos-Bonded ARMCO Paved Pipe. The flexible, corrugated metal design guards against breakage, and sturdy band couplers assure strong, tight joints. Corrosion is baffled by a full bituminous coating tightly bonded to the galvanized ARMCO Ingot Iron base. A thick pavement of the same special material protects the bottom—where the wear is most severe.

ARMCO Corrugated Pipe brings other desirable advantages. It combines adequate strength with light weight for easy handling and hauling in long lengths. Naturally longer lengths mean fewer joints, lower installation costs. Unskilled men can do the work in any season, using simple tools. Curing is eliminated.

Use Asbestos-Bonded ARMCO Pipe for your next sewer line. You will save money and avoid trouble, especially on the tough jobs. Write for prices and complete information. ARMCO DRAINAGE PRODUCTS ASSOCIATION, 5059 Curtis Street, Middletown, Ohio.

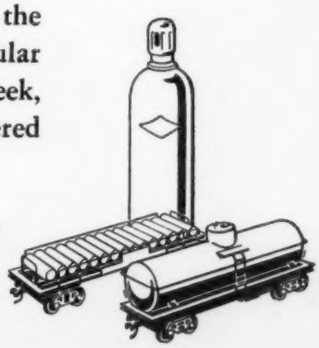
Asbestos-Bonded ARMCO **ARMCO SEWER PIPE**



Silent SENTINEL

Silently protecting the patrons of swimming pools and beaches, the dependable, uniform purity of Diamond Liquid Chlorine provides complete assurance of safety in a vital phase of your responsibility.

For your convenience, Diamond Liquid Chlorine comes to you in the type of modern, trouble-free container best adapted to your particular needs. Whether you use an occasional cylinder or a tank car a week, you can count on uniformly pure, full strength, safely delivered Liquid Chlorine when you SPECIFY DIAMOND!



DIAMOND ALKALI COMPANY

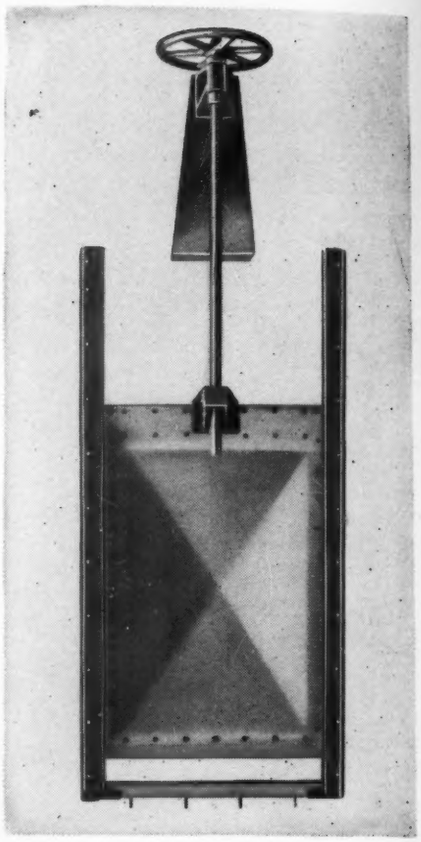
Pittsburgh, Pa., and Everywhere

Everdur

COPPER-SILICON ALLOY

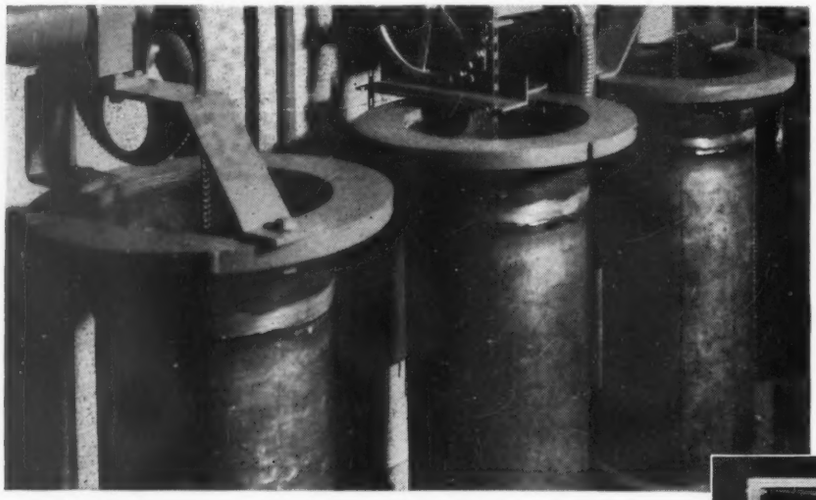
Gets the Call in Sewage Treatment

COMBINING high resistance to corrosion with high strength, ease of fabrication and ready weldability, Everdur is uniquely adapted to light weight structures built of wrought metal. Over a period of 14 years, this moderately priced copper-silicon alloy has demonstrated its superiority for sewage treatment equipment under a wide variety of operating conditions. Anaconda Publication E-11 contains detailed information of interest to sewage and water works engineers.



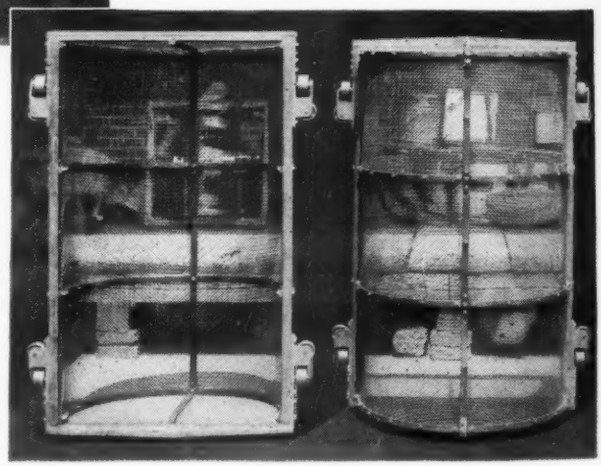
(above)

● One of five easily *hand-operated* Everdur shut-off gates in the screen room of the Rahway Valley Joint Meeting Sewage Treatment Works, Rahway, N. J. The frame is cast Everdur, the plate is rolled Everdur, the 2½″ spindle is machined Everdur rod. Height of frame—10′ 3″; total weight only 1,624 lbs.



(above)

● Control mechanism of 12″ diameter Everdur float tubes. Designed and built by Krajewski-Pesant Mfg. Corp., for the Ward's Island Sewage Treatment Works of the City of New York. In the air filters in both primary and secondary rooms at Ward's Island, entire filter structures, filter holders, retaining mesh and rotating screen were made of Everdur by the American Air Filter Co., Inc., Louisville, Ky.



(right)

● Two types of Everdur screen frames used by New Haven Water Company at main outlets in reservoirs. Principal uses of Everdur in reservoirs and water distribution systems include screens, screen frames, spillway fittings, flashboard supports, bolts, steps, valve stems, flush box fittings and pipe.

41147

ANACONDA
from mine to consumer

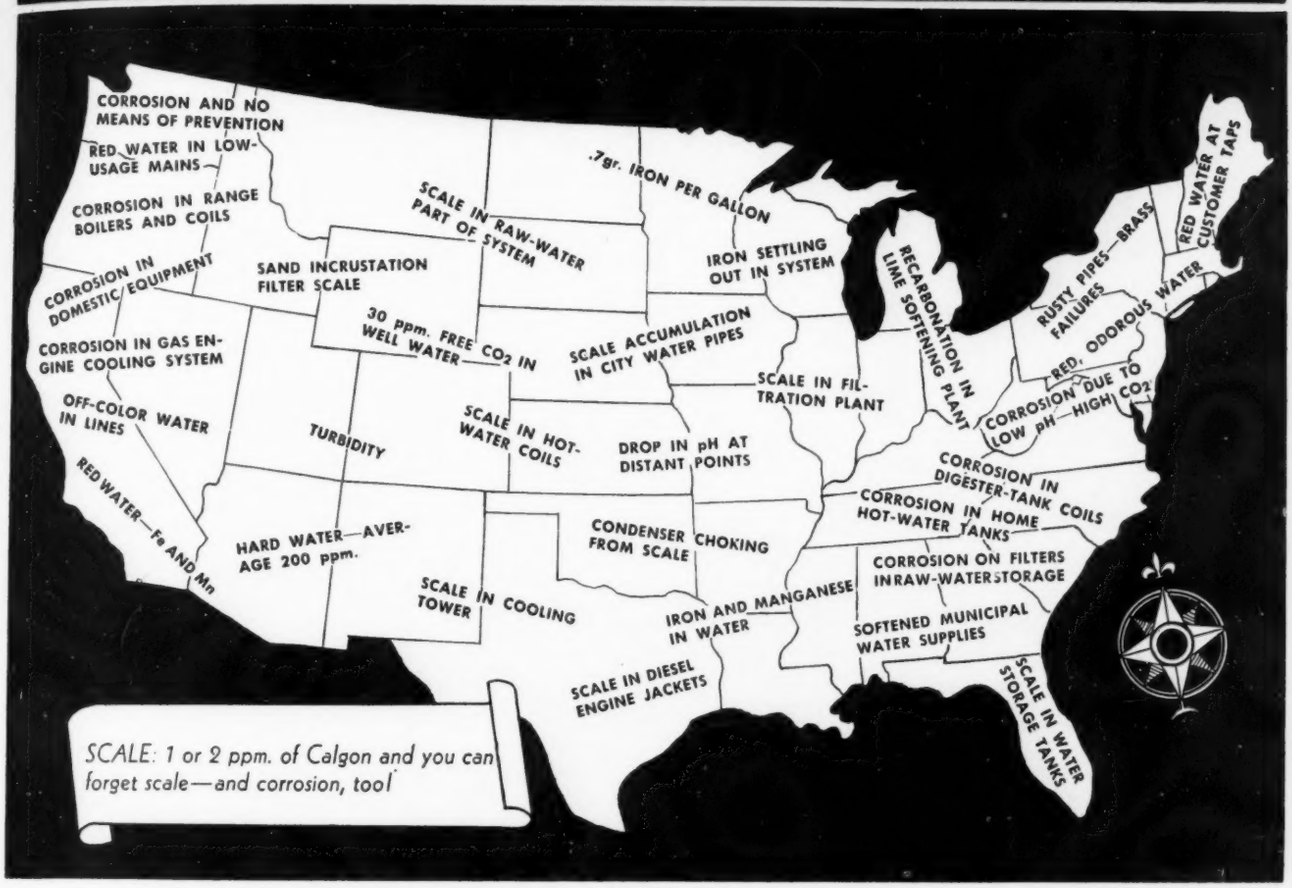
Everdur Metal

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Company*

"EVERDUR" is a trademark of The American Brass Company, registered in the United States Patent Office.

In what state of trouble are you?


CORROSION AND NO MEANS OF PREVENTION
RED WATER IN LOW-USAGE MAINS
CORROSION IN RANGE BOILERS AND COILS
CORROSION IN DOMESTIC EQUIPMENT
CORROSION IN GAS ENGINE COOLING SYSTEM
OFF-COLOR WATER IN LINES
RED WATER—Fe AND Mn
SAND INCRUSTATION FILTER SCALE
SCALE IN RAW-WATER PART OF SYSTEM
30 ppm. FREE CO_2 IN WELL WATER
TURBIDITY
HARD WATER—AVERAGE 200 ppm.
SCALE IN HOT-WATER COILS
SCALE IN COOLING TOWER
.7gr. IRON PER GALLON
IRON SETTLING OUT IN SYSTEM
SCALE ACCUMULATION IN CITY WATER PIPES
DROP IN pH AT DISTANT POINTS
CONDENSER CHOKING FROM SCALE
IRON AND MANGANESE IN WATER
SCALE IN DIESEL ENGINE JACKETS
RECARBONATION IN LIME SOFTENING PLANT
SCALE IN FILTRATION PLANT
RED WATER AT CUSTOMER TAPS
RUSTY PIPES—BRASS FAILURES
RED, ODOROUS WATER
CORROSION DUE TO LOW pH—HIGH CO_2
CORROSION IN DIGESTER-TANK COILS
CORROSION IN HOME HOT-WATER TANKS
CORROSION ON FILTERS IN RAW-WATER STORAGE
SOFTENED MUNICIPAL WATER SUPPLIES
SCALE IN WATER STORAGE TANKS
SCALE: 1 or 2 ppm. of Calgon and you can forget scale—and corrosion, too!

Fight scale and corrosion now . . . with Calgon!

THAT municipal water plants throughout the country are experiencing scale or corrosion difficulties is apparent from the numerous problems that are constantly being brought to our attention.

Why do water works men come to us in scores with these problems? Because they have heard about Calgon, read about Calgon's effectiveness elsewhere, and feel that perhaps Calgon can help them.

And Calgon *can* help them, is helping them in rapidly increasing numbers. Moreover, it can help *you*.

Calgon enables you to *deliver* water, near or far, that has the same high quality as the water *leaving* your plant — stabilized water that prevents the costly nuisances of scale and "red water."

Being in trouble is one thing; staying in it is another. By all means, fight scale and corrosion *now*—with Calgon. It is a sound, accepted remedy— efficient, dependable and economical. Only small amounts are required. No costly equipment is necessary. At its new low price, Calgon is a water works "must."

VISIT THE CALGON EXHIBIT

at the 61st A.W.W.A. Convention in Toronto. A visual demonstration of Calgon's ability to control corrosion will be featured.

WATER WORKS APPLICATIONS OF CALGON*

Calgon, a molecularly-dehydrated, sodium-phosphate glass, solves four major water problems.

1. Controls corrosion.

2. Prevents precipitation of dissolved iron.

3. Stabilizes water following softening.

4. Prevents scale formation from hard, high-bicarbonate waters.

** Calgon is the registered trade-mark of Calgon, Inc. for its glassy sodium-phosphate products.*

Calgon, Inc., Pittsburgh, Pa.
Please send free sample and data on: Corrosion Control ☐ Scale Prevention ☐

*My problem is*_____

*Name*_____

*Affiliation*_____

*Address*_____

*City*_____ *State*_____

calgon, inc.
300 ROSS ST. PITTSBURGH, PA.

THEY "SHOW UP" IN SLUDGE LINES

Crane No. 778 Light Standard Double Disc Gate Valves

At a glance, these iron body outside screw and yoke valves show exact position of the disc. Ideal for manifold service in sludge tank lines. Rated at 100-pounds water, they save the extra cost of heavier valves. Crane non-jamming disc design assures smooth operation and tight seating.

• • •

For the right valves for specific working conditions, look to the Crane line of over 38,000 piping items for every service. There's a Crane Branch or Wholesaler nearby—ready to serve you.

CRANE

VALVES • FITTINGS
PIPE • PLUMBING
HEATING • PUMPS

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILL.

TAFFY IS OUT!

One of the principal causes of chlorinating system ailments is "taffy"—the sticky gum caused by impurities . . . such as hexachloroethane, hexachlorobenzene and acetylene tetrachloride . . . in liquid chlorine.

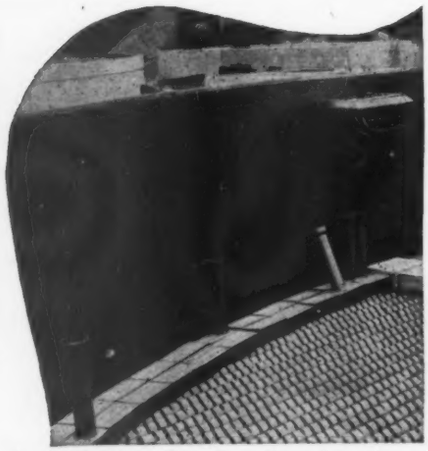
But now taffy is out. No more taffy-clogged chlorinator orifices. No more time out for cussing and cleaning.

Pennsylvania Salt has developed a special fractionating column for producing taffy-free liquid chlorine. And to make sure that you get the dependable service you want, Pennsylvania Salt supplies this improved liquid chlorine in double-checked cylinders...twice inspected and tested for leaks...clean and in perfect working condition.

FREE WALL CHART with 20 valuable suggestions on "Handling Liquid Chlorine." Write for one to hang near your chlorinator. Pennsylvania Salt Manufacturing Co., Widener Bldg., Philadelphia, Pa.—New York • Chicago • St. Louis • Pittsburgh • Wyandotte • Tacoma.

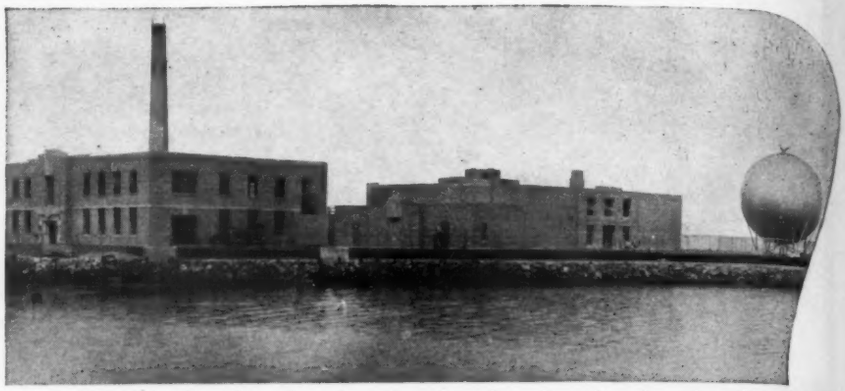
LIQUID CHLORINE

PENNSYLVANIA SALT
MANUFACTURING COMPANY
Chemicals

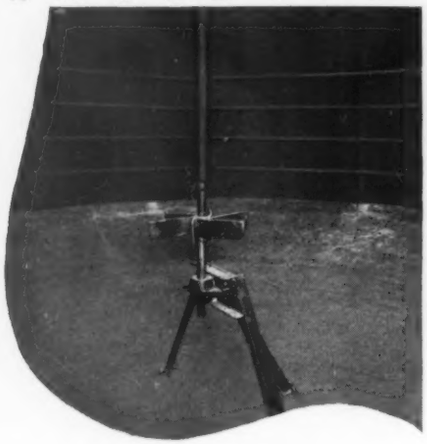


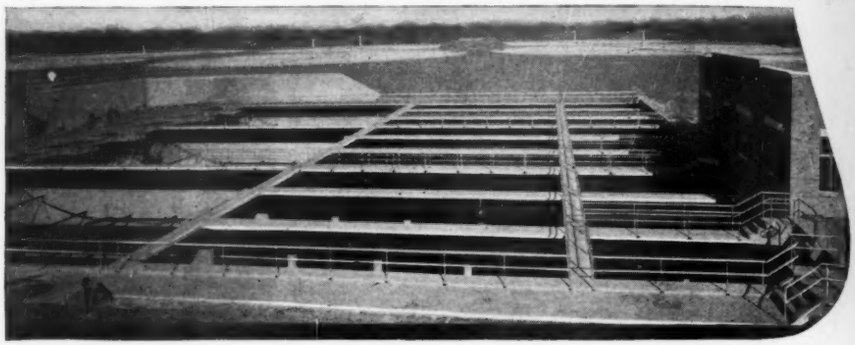
← KUTZTOWN

NEW HAVEN ↓



★ ★





← HUDSON FALLS

DALLAS ↑

Join the trend towards BITUMASTIC N° 50

When leading sewage engineers and contractors for such plants as those shown above specify Bitumastic No. 50—it's good evidence of the fast growing trend towards this latest member of the famous Bitumastic family.

With a heritage of nearly 80 years in guarding against the most difficult under-ground and under-water corrosive conditions, this recent Bitumastic coating is being used today on tanks, grit channels, foundation walls below grade, weir plates and other concrete and metal surfaces in sewage plant construction.

Bitumastic No. 50 is a coal tar base product and contains no water or asphalt. It is applied cold to a very heavy film—up to 1/16 of an inch in multiple coats on a vertical surface, without appreciable running or sagging while wet. Having a plastic appearance in the container, stirring quickly changes it to application consistency.

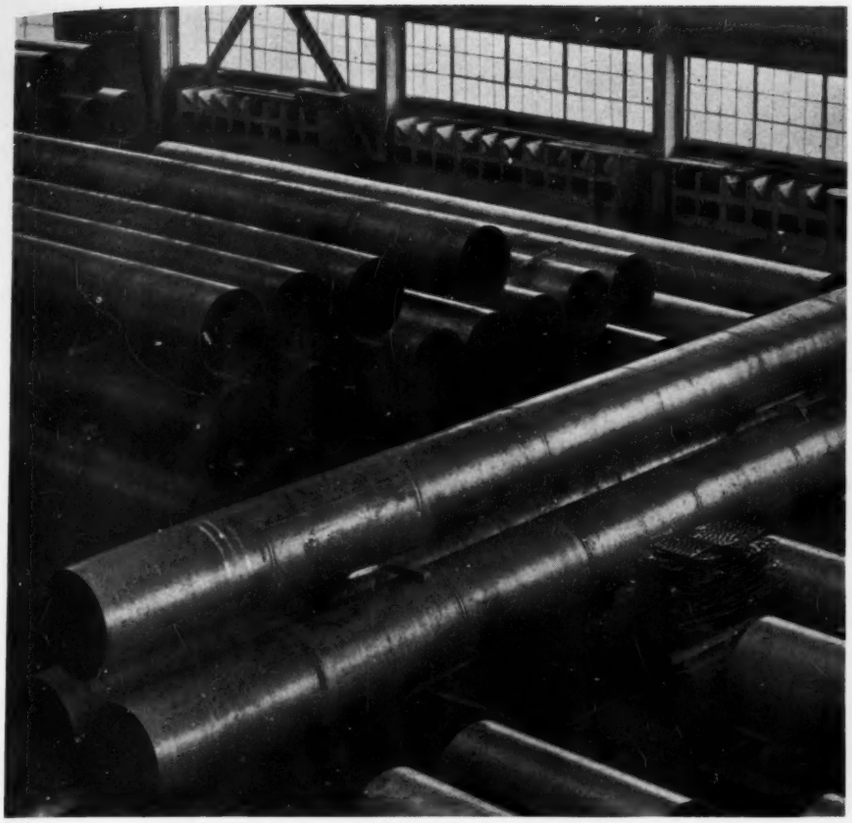
Send for bulletin No. 1140 giving detailed specifications of Bitumastic No. 50 . . . and No. 838 which describes the applications of all Bitumastic products to sewage plants and structures.

★ ***We also manufacture a complete line of industrial maintenance paints.***

WAILES DOVE-HERMISTON CORPORATION

WESTFIELD • NEW JERSEY

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • HOUSTON • TULSA • SAN FRANCISCO • LOS ANGELES • MIAMI



56 foot lengths of 42 in. diam by 3/8 in. steel pipe.

Let us quote you on

WELDED STEEL PIPE

ILLUSTRATED above are stacks of welded steel pipe awaiting coating and lining applications, before being shipped for water main service.

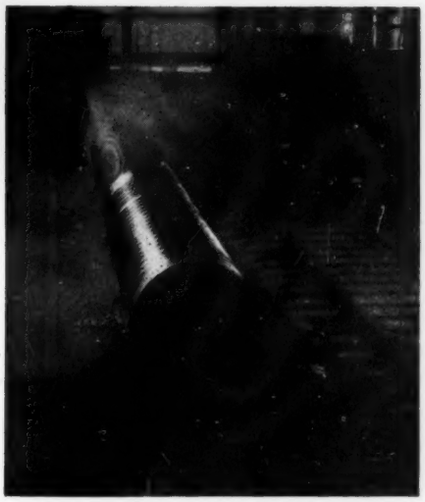
The use of welded steel pipe in solving municipal and industrial water transmission problems is becoming more and more widespread. To meet this increasing demand, Chicago Bridge & Iron Company offers complete facilities for fabricating steel pipe 30-in. in diameter or larger. Sections up to 60 ft. in length are tested, cleaned, grit-blasted, primed and coated on the inside and the outside all in one piece. The decrease in the number of field joints due to the use of long lengths results in an appreciable saving in installation costs.

The enamel lining, which is spun on the inside of the pipe centrifugally, gives steel pipe high carrying capacity. A similar coating on the outside protects the metal and assures long life.

Write our nearest office for quotations or estimating figures on welded steel pipe, steel tanks or steel plate work of any kind. No obligation, of course.

COATING FACILITIES

After being tested, cleaned, grit-blasted and primed, a tar enamel lining is spun on the inside of the 60-ft. sections.



The same pipe coating machine is used to coat the outside surface of the pipe.

The pipe, coated inside and out, is removed from the coating machine and loaded on cars for shipment.

CHICAGO BRIDGE & IRON COMPANY

Chicago	2198 McCormick Bldg.	Birmingham	1586 North 50th Street	Philadelphia	1644-1700 Walnut St.
New York	3390-165 Broadway Bldg.	Tulsa	1646 Hunt Bldg.	Boston	1548 Consolidated Gas Bldg.
Cleveland	2262 Builder's Exchange	Houston	918 Richmond Avenue	San Francisco	1083 Rialto Bldg.
Dallas	1679 Praetorian Bldg.	Detroit	1551 Lafayette Bldg.	Los Angeles	1455 Wm. Fox Bldg.

Plants at **BIRMINGHAM, CHICAGO, and GREENVILLE, PA.** *In Canada:* **HORTON STEEL WORKS, LIMITED, FORT ERIE, ONT.**

You'll get positive, economical sewage coagulation with

Ferric Chloride

(anhydrous and liquid)

Ferric Chloride
(anhydrous and liquid)

is the supreme sewage coagulant for

- Sludge Dewatering
- Raw Sludge
- Raw Activated Sludge
- Digested Sludge
- Mixed Sludge
- Coagulation
- Raw Sewage
- Settled Sewage
- Industrial Sewage
- Mixed Industrial and Domestic Sewage

Ferric chloride is a positive coagulant for sewage, producing extremely clean-cut flocculation in economical doses. In most communities, ferric chloride offers substantial savings over alum.

And Pennsylvania Salt, pioneer in producing liquid ferric chloride for use in sewage disposal, has also pioneered in developing economical and effective methods of using this valuable coagulant. Our data files and engineering assistance are yours to command.

Aqueous ferric chloride varies in concentration from 39% $FeCl_3$ in extremely cold weather to 45% $FeCl_3$ in extremely hot weather. It is shipped in rubber-lined 8000-gal. tank cars, averaging 40,000 lb. of dissolved $FeCl_3$ per car.

Anhydrous ferric chloride is supplied by Penn Salt in water-free form, as nearly 100% $FeCl_3$ as possible. It is shipped in non-returnable steel drums, 150 and 400 lb. sizes.

Call on us for technical service in connection with your chemical sewage treatment problems. Pennsylvania Salt Manufacturing Co., Widener Bldg., Philadelphia, Pa.—New York • Chicago • St. Louis • Pittsburgh • Wyandotte • Tacoma.

REG. U.S. PAT. OFF.

PENNSYLVANIA SALT MANUFACTURING COMPANY

Chemicals

Why STEEL WATER LINES insure low-cost maintenance and long-time service

Factors responsible for the trend to STEEL WATER LINES...

1. *High Strength.* Withstands high pressures, heavy trench loads, vibrations, shocks, washouts, water hammer and other emergency stresses.
2. *Long Lengths.* Fewer joints per mile, faster laying, less damage to pavement, lower water loss.
3. *Light Weight.* Saves freight and trucking charges. Speeds laying. Cuts laying costs.
4. *Shatterproof.* Eliminates sudden ruptures in case of fire and emergencies. Reduces property damage.
5. *Smooth Surface.* Ideal for linings or coatings, where necessary. Greater carrying capacity.
6. *Long Service.* Sixty-year old installations still in service.

HERE'S PROTECTION *for the City of Asheboro, N. C., for years to come. This installation calls for 6,000 ft. 12¾"O.D.,* NATIONAL *Line Pipe. The* NATIONAL *Steel Pipe supplied here had to meet particular requirements of the local water works engineer—another example of National's service.*

STEEL PIPE is the only water line material that gives you all these features. And remember, you can bend it, twist it, and even flatten it; but unlike frangible materials, it will not break or shatter. NATIONAL Steel Pipe has proved, beyond a doubt, its dependability and that is why it is being specified by the country's leading water works engineers and superintendents. NATIONAL is made in accordance with A.W.W.A. Specifications.

There are many factors which interfere with the operation of a water system that you can't control, such as earth settlement, traffic vibration, tuberculation and corrosion. *But* you can minimize them to a controllable degree if you specify NATIONAL Steel Pipe! It will give you the most service per dollar of cost—the greatest safety and freedom from trouble that money can buy. Write today for Bulletin 21, complete information on NATIONAL Steel Pipe for underground water lines.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

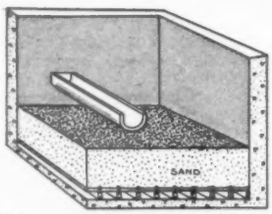
UNITED STATES STEEL

Designing a new filter plant?

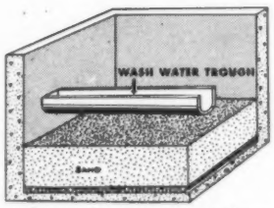
Improving an old one?

IF SO, IT WILL PAY YOU TO INVESTIGATE THE BENEFITS OF THE ALOXITE BRAND POROUS UNDERDRAIN SYSTEMS

1. *Elimination of filter bottom troubles... protection against loss or upset of filter media... no corrosion.*
2. *Longer filter runs... uniform back wash.*
3. *Lower pumping costs... reduced heads.*
4. *Lower cost of construction.*



Filter with plain plates forming a false bottom



Filter with channeled plates

POROUS CARBORUNDUM PRODUCTS

Make your plans to attend the 61st Annual Meeting of the American Water Works Association, Toronto, Ontario, Canada, the week of June 22d to 26th, 1941.

Now being proved in more than 60 separate installations throughout the world

THESE benefits are realized through the inherent simplicity of design of the Aloxite Brand Porous Underdrain System which results in the complete elimination of graded gravel and the reduction of all vertical dimensions. Our sanitary engineers will gladly furnish consulting engineers, plant superintendents and others who are interested with further details. Write direct to the Niagara Falls office.

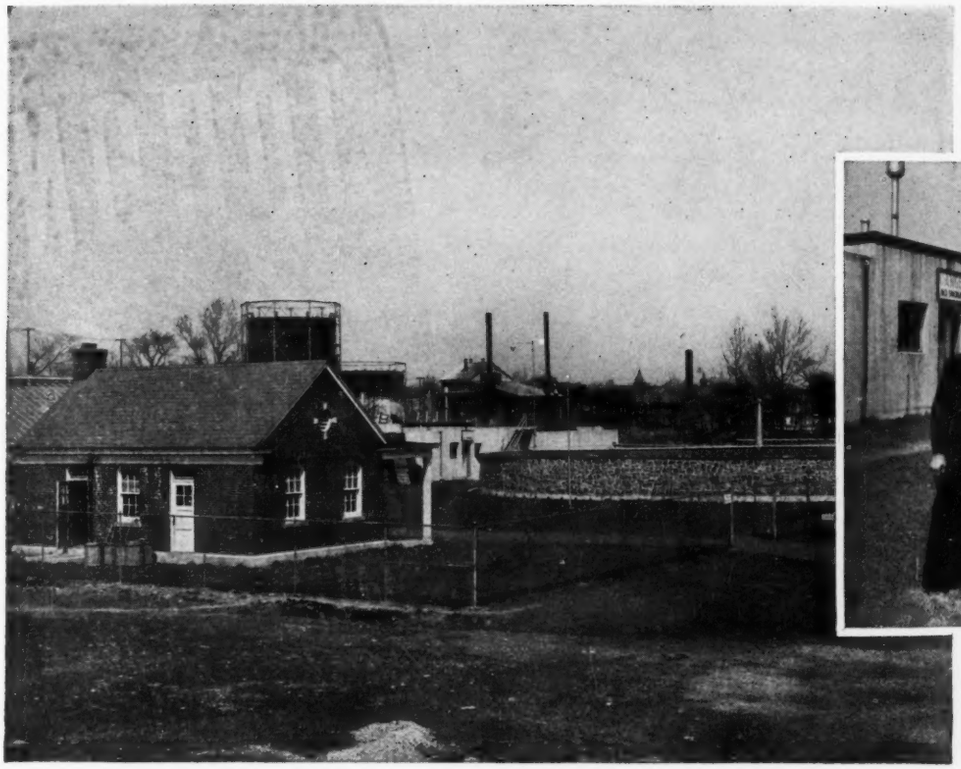
THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

Niagara Falls, N. Y.

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum and Aloxite are registered trade-marks of and indicate manufacture by The Carborundum Company)



Plan to attend 61st meeting of A. W. W. A.— Toronto, Ont., June 22nd—26th.

G. L. Palmer, Superintendent

Stroudsburg, Pa.

USES MATHIESON CHLORINE AND HTH

for sewage treatment

"(And)...we are completely satisfied," says Gilbert L. Palmer, Superintendent

Mathieson Chlorine and HTH have been used in this modern sewage treatment plant at Stroudsburg, Pa. since the plant was first put in operation in 1937. Both products have been used continuously since that time... rendering "completely satisfactory" service. Mathieson Chlorine for post-chlorination and HTH in the dosing chamber for the elimination of filter flies—also for regular dosing of the beds.

Satisfactory service is an old story to Mathieson Chlorine and HTH. Stroudsburg is only one of hundreds of cities and towns that find Mathieson sanitation service both dependable and efficient. In Mathieson Chlorine you get *pure* chlorine and prompt delivery in well kept, trouble-free containers. HTH, also, in addition to its use on everyday sanitation jobs, should be kept on hand for quick emergency service requiring a mobile, high-test chlorine carrier.

Write us for full information on Mathieson Chlorine and HTH.

HTH comes in 5-lb. cans with replaceable caps, packed 9 cans to the case; also in 100-lb. drums.

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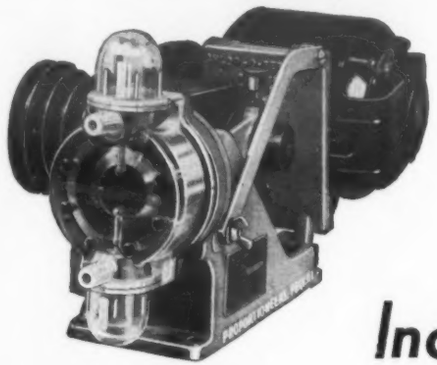

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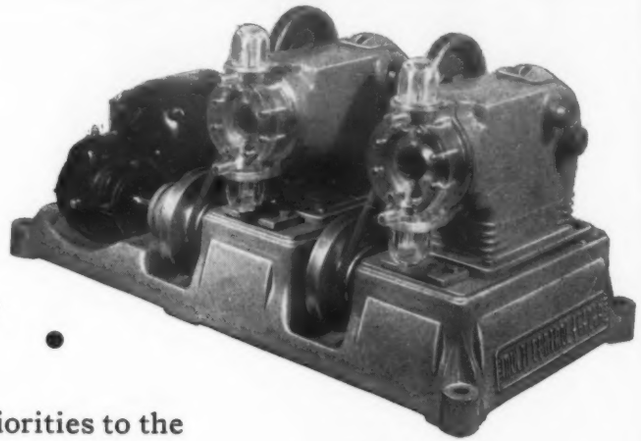

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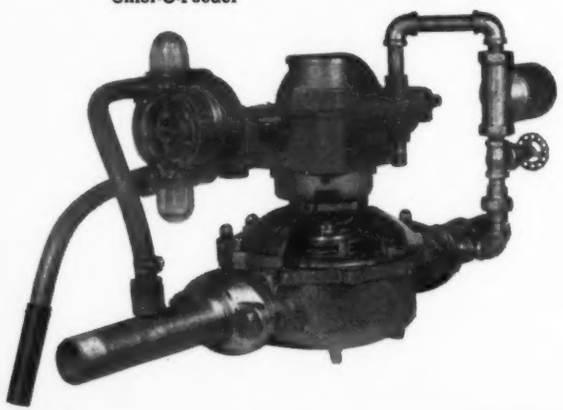

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W. D. KELLEY, Consulting Engineer, Beckley, W. Va.

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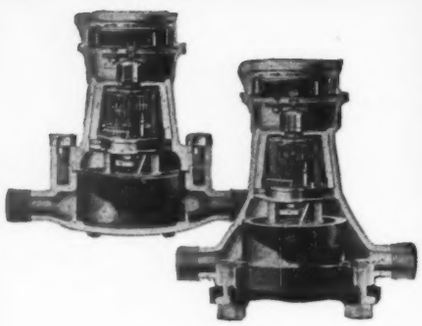

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WATER WORKS & SEWERAGE

VOL. 88, NO. 5 *A Gillette Publication* MAY, 1941

FILTER WASHING

Some Observations on and Results with Methods Old and New

By

H. J. KRUM
Supt. of Filtration
ALLENTOWN, PA.

and

I. M. GLACE
Consulting Sanitary Engineer
HARRISBURG, PA.

The Authors
Krum and Glace

THE authors of this paper, although having no official connections, have nevertheless cooperated for years on the solution of the many difficulties incident to the proper maintenance of public water supplies and the collection and disposal of sewage, including certain research and operating problems. The care of filters, naturally, has been one of the matters considered.

This association has been unusually beneficial to both authors and the more effective, it is felt, because one author (Krum) has had available a large and well equipped laboratory for chemical and bacteriological studies and, as chief operator of a ten million gallon rapid sand filter plant as well as several smaller swimming pool filters, has been able to install for experimental purposes many devices of varying kinds, and to put into practice a number of improved operating procedures.

Although the authors confess to differences of opinion on some of the practices of the profession, they find themselves in complete agreement on the desirability of better facilities for the cleansing of the media of filter units, and on the efficiency of the socalled surface-wash.

The data and conclusions presented herein represent a consolidation of ideas and opinions based on detailed research at one plant and on general observations at plants over a wide area.

Past Practices

For the sake of clarifying this discussion, and in an attempt to indicate briefly the struggle of the profession to solve this knotty problem of filter operation, the historical outline which follows is cited to show approximately the time periods in which certain designs and practices have been popular in the water works field:

—Prior to 1910—

In circular tub filters; with false bottoms, pipe laterals, a variety of types of strainer heads and, commonly, revolving fixed rakes, with "low" wash water rates of 8″ to 12″ rise per minute.

1910 — 1920

In rectangular concrete units; with slightly increased wash water rates, and frequently air wash as an auxiliary.

1920 — 1930

As in 1910-1920, but with "moderate" rates of wash up to about 30″ rise, and with perforated lateral pipes and deeper gravel beds for better distribution.

1930 — 1940

As in 1910-1920, but with "high" rates of wash up to 48″ rise per minute, a variety of filter bottoms, many of a nonmetallic character, and frequently false bottoms to replace manifolds and laterals.

Surface wash was introduced as an auxiliary to the bottom wash, with either fixed or revolving piping at the surface of the medium for such purpose. The introduction of porous plate filter bottoms, eliminating the gravel bed.

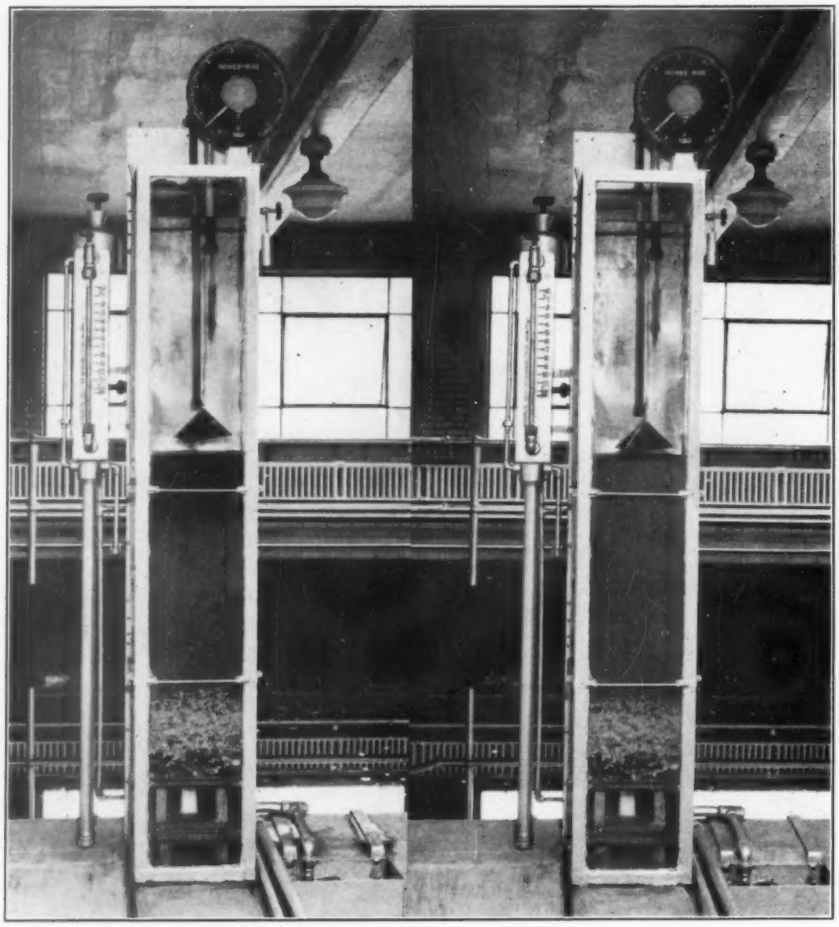
Seemingly most of the difficulties in filter washing began with the advent of the rectangular concrete box filter. This period coincided with the abandonment of the circular wooden-tub type filter and mechanical rakes.

The time periods indicated are, perforce, only approximations and considerable overlapping naturally occurs in any such classification. As for instance, perforated pipe laterals were used as early as 1905, at the Harrisburg, Pa., works.

Mention should be made of the use of slat-bottomed units which, generally, have never been accepted by the profession because they seem to violate one of the basic principles of design; that is, the production of a uniform head at the base of the strainers, or other openings through restricted orifices.

Mention might be made, also, of the use in a number of plants of fine mesh screens, installed between the top of the gravel layer and the sand bed to prevent "upsetting" of the gravel; a condition which, it is not generally recognized, exists to some extent in practically all units not in some way protected against disturbance. This point in the filters—the junction of the sand and gravel—might well be classed as the "danger line," since a serious upset at this junction of the two media results finally in the failure of the bed to perform its functions and, ultimately, in the necessity for a complete and expensive overhauling of the affected unit. The seriousness of this problem brought forth the development of the porous-plate false bottom, a very promising improvement in design.

In addition to the listed methods of construction, an



The Allentown Experimental Filter

Fig. 1 (left) shows the layer of coated top sand after many repeated washings at high rate bottom wash alone.

Fig. 2 (right) reveals the result of sand scour secured by surface-jet wash for only a short period.

The hanging cone is the sand bed expansion indicator developed at Allentown for indicating correct washing rates throughout the year.

enormous amount of time and effort has been given to a study of the sizing and specific gravity of the filtering media, resulting, from a design standpoint, in the use of anthrafilt in many filters, and the use of coarser sands of a larger effective size.

All of this—revolving rakes, air wash, false bottoms, screens as gravel retainers, "high" rates, and what not, even when combined with greatly improved mixing and coagulation of chemicals—has not resulted in the design or use of any one "best" procedure, or in the prevention of mud-balls, hard spots, and the necessity for the frequent expensive overhauling of the units; nor has it provided operators with means for maintaining a really *clean* filtering medium.

It is admitted that in some of the more carefully designed and better operated plants these interferences in filtration have been held to a minimum but so far as the water works field generally is concerned, the results are as stated above.

High Wash Rates Disappointing

Of these various features of design, the so-called "high" wash rate seems to have been the greatest disappointment and the most misleading. A rise of as much as 48″ per minute is exceptional but when this is expressed, as it might well be, as 4 feet per minute, the actual low velocity of such a flow can be more readily recognized. Although the actual velocities through the interstices of the expanded sand may be 2 to 3 times this stated velocity, but little sand scrubbing effect results.

The Surface Wash

Various forms of surface wash have been developed in the last half dozen years (not considering the old revolving rake in this classification) with almost universal improvement in operation.[1, 2] The development of the relatively inexpensive and easily installed Palmer Filter Bed Agitator has speeded up the trend towards such a form of auxiliary wash since it was introduced to the field in 1939, and first described by the inventor, a filter operator, in this magazine.[3]

The success of these various forms of surface wash is the result of the relatively high velocities of the jets issuing from the distributor arms, which velocities commonly reach from 50′ to 100′ per second, or 1,000 times that of the socalled "high rate" bottom wash. The tremendous scouring action of these fire stream velocities is at once apparent.

Some Allentown Observations

When Hulbert and Herring[4] first directed the attention of the profession to the importance of the degree of expansion of the sand bed in filter washing and emphasized the higher efficiency of the more viscous low temperature water, in expanding the media, the authors became interested in the importance of wash water control to secure effective bed expansion under all conditions. To this end Krum, in cooperation with the Simplex Valve and Meter Co., developed the sand expansion indicator, now used successfully in many plants. Data on these studies was first published in WATER WORKS AND SEWERAGE.[5]

For the Allentown experiments a model filter unit with glass sides was constructed. It had an effective area of one square foot and was built to full vertical scale. It was equipped with the perforated concrete Leopold bottom, a duplicate of the block originally installed in the Allentown plant. In other words, the experimental unit is an exact replica of a 12-inch square section of the full size filters—see Fig. 1.

Sand for the experimental unit was taken from one of the plant filters, using a perpendicular column of sand extending from the surface down to the gravel layer. The sand at the bottom of this column had the appearance of clean sand, but the top 8 inches was black in color and had a coating of impurities, approximating 20 per cent by weight. This experimental bed was washed repeatedly, probably 200 or 300 times, at wash rates which expanded the sand in varying degrees up to 60 per cent.

During the course of these experiments on the rate of expansion no new sand was added to the filter; nor, although the unit is equipped to receive coagulated and settled water, was such water applied to the unit. The coated condition of the top sand at the end of the repeated high rate washings in these experiments is re-

vealed in Fig. 1. In the photograph it has the appearance of a layer of black water rather than sand.

At the conclusion of these expansion experiments a fixed jet surface wash of the Baylis type, shown in Figs. 1 and 2 as a perpendicular pipe extending downward and ending 3 inches above the top of sand bed, was installed in the experimental filter to determine whether or not the coating on the sand grains could be removed by this method of washing. The results were startling. The application of the high pressure water jets to the unexpanded sand created a violent movement in the top 8 inches of the bed. This scoured the sand so effectively that the supernatant water immediately became opaque because of the turbidity, and was black in color. After two minutes of this initial scouring of the settled bed, wash water was introduced from below and the entire bed of sand expanded 50 per cent. The resulting downward movement of the upper sand, due to the action of the surface jets, and contact with the upward movement of the lower sand due to the back wash, caused a second violent scouring, with a penetration to 18 inches below the surface. Repeated washing of the sand in the experimental unit by this method resulted in the disappearance of the black coating on the top sand, and the entire volume of sand attained the appearance of uniformly clean sand, as revealed in Fig. 2.

This demonstration convinced the authors of the comparative inefficiency of the normal method of washing filters. Observations, in other plants have simply confirmed this conviction and further convinced us of the comparative inefficiency of the normal method of washing filters.

Full Plant Scale Data

The Allentown filter plant was built in 1928 and takes water from the Little Lehigh River, a stream draining a fertile farming area, with consequently widely varying turbidities. The works comprise an intake well with screens, low lift pumps, a baffled mixing basin, with an actual retention period of about 20 minutes for floc formation, duplicate sedimentation basins of about 2 hours capacity, and 8 rectangular filter units with a capacity of 1.25 m.g.d. each. Alum is used as a coagulant, with pre- and post-chlorination. The only unusual features of the plant are the non-metallic Leopold Duplex Filter Bottoms. The raw water alkalinity is above normal for Pennsylvania and somewhat hard, but is not grossly contaminated. Some few industrial wastes in minor quantities are present in the water.

The history of the Allentown filter units is typical of many other plants, with probably an average amount of mud ball formation, some gravel disturbance, and an occasional hard spot at the outer perimeter of the units and in the corners. Since the plant was built in 1928 the sand has been ejected from the filters twice for the

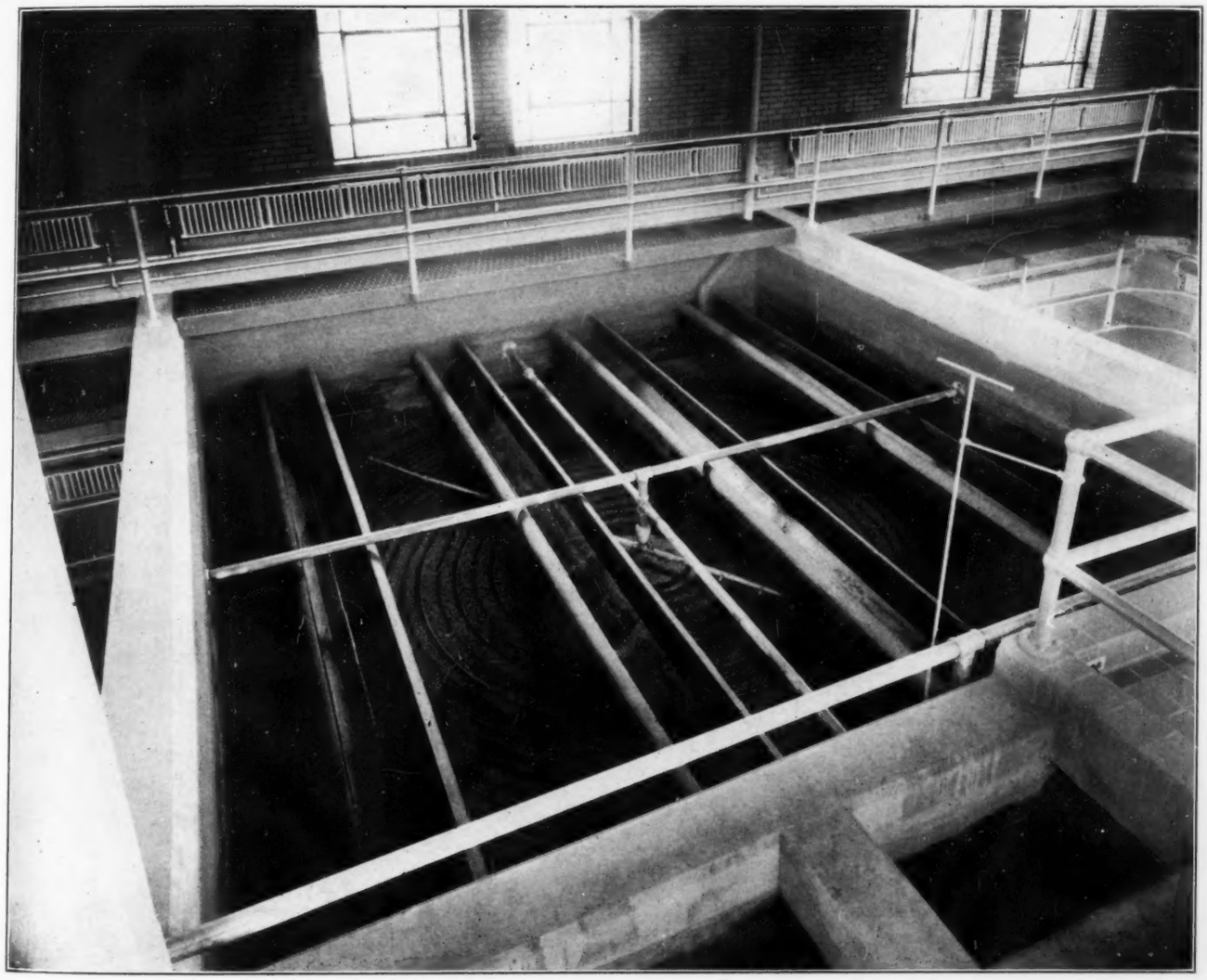


Fig. 3—One of the 1.25 M.G.D. Filters Equipped with Palmer Revolving Agitators

purpose of breaking up mud balls and to examine the condition of the gravel layers.

Conditions at Allentown, the authors feel, average the field quite generally except for the absence of troubles commonly due to metallic bottoms. The plant is operated at full rates with daily shutdowns of several hours each day.

After due consideration of the condition of the filters and other factors involved, and because of the results observed in the experimental filter, a rotating Palmer Filter Bed Agitator was installed in filter No. 3 in April, 1940. The results were so satisfactory, from a visual standpoint, that four additional filters were equipped with Palmer Agitators, the first being installed in July, 1940, and the last two in April, 1941. The remaining three filters in the plant are likewise to be equipped before the end of 1941.

The surface dimensions of the Allentown filters are 20 feet by 22 feet. The Palmer Agitator installed consists of one brass unit with properly placed jets and with an overall length of 19½ feet, the longest arm used anywhere, according to the manufacturer, up to the time of the last installation. In order to provide rigidity for the agitator, sections of galvanized pipe 2½ inches in diameter in the form of a cross are fastened to the four walls of the filter with wall flanges —see Fig. 3.

Mud Ball and Coating Reductions

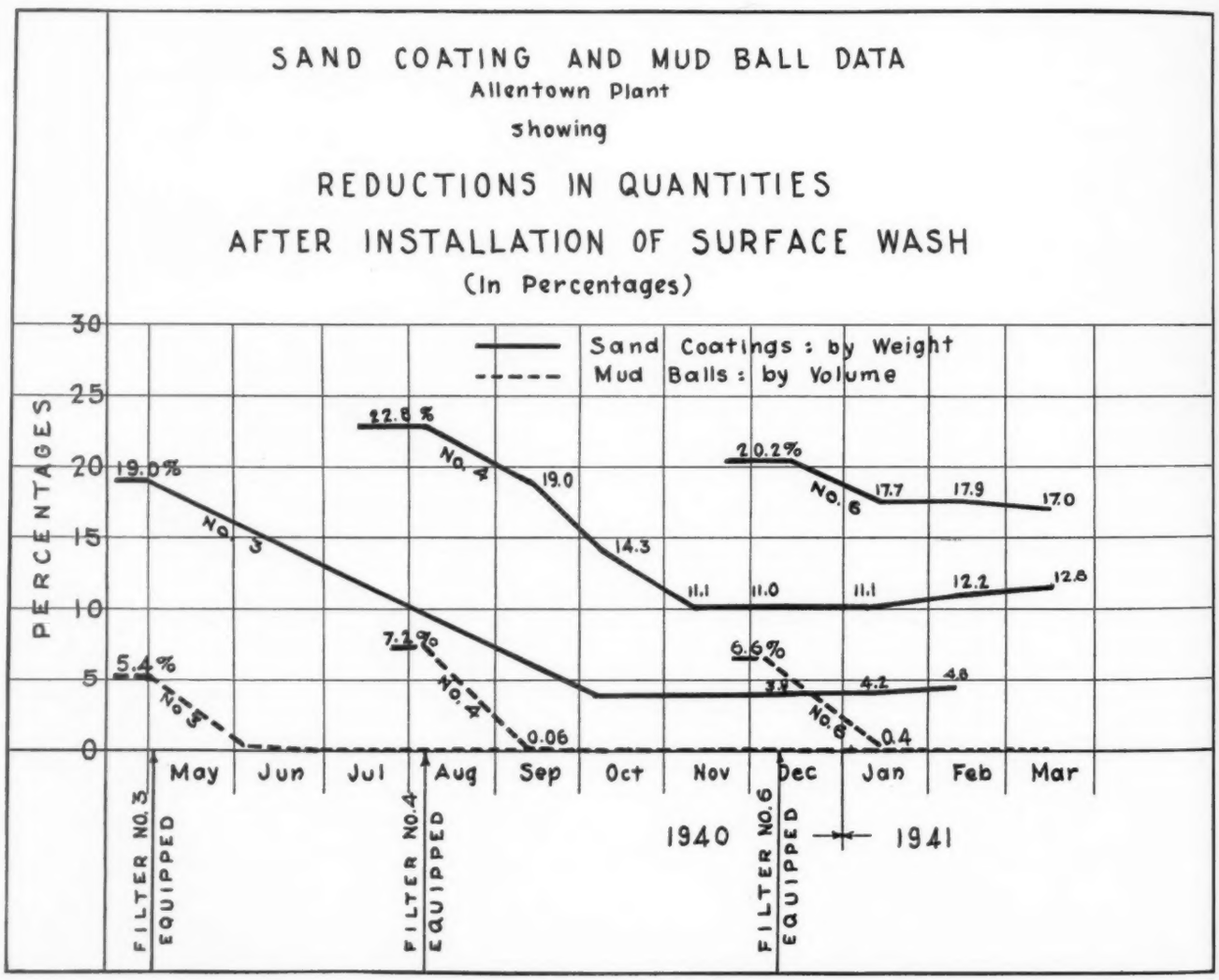
Before the second installation was completed in August, 1940 (filter No. 4), samples of sand were taken from the top 6 inches of the bed and the volume of mud balls accurately measured, using the method advocated by Baylis.[6] In addition, the amount of coating on the sand grains was determined by treating a weighed sample with concentrated hydrochloric acid, washed, dried and reweighed.[7]

These determinations have been repeated monthly since that time. It will be noted in Table 1 and Graph 1 that the average amount of mud balls in the top 6 inches of the seven filters not equipped with agitators was 5.6 per cent. In filters No. 3 and 4, equipped with agitators, after one month of service practically no mud balls remained.

TABLE No. I

Filter	% Mud Balls	— Sand Characteristics — Eff. Size	Uniformity Coef.
No. 1	4.3	.63	1.35
No. 2	4.6	.53	1.32
No. 3	0*	.60	1.50
No. 4	7.2	.53	1.40
No. 5	8.3	.55	1.36
No. 6	6.0	.55	1.36
No. 7	2.9	.54	1.40
No. 8	6.1	.69	1.30

*Not tested previous to installation of Palmer agitator. Tests—October 29, 1940.



Graph 1—Sand Coating and Mud Ball Records

Revealing Rapidity with Which Surface Wash Removes Sand Coatings and Clears Out Mud Balls.

Unfortunately, no sand coating test was made on the sand in filter No. 3 prior to the installation of the agitator. However, the average coating on the sand in filters No. 4, 5 and 6 before the installation of the agitators was 23.4 per cent. The rate of reduction in sand coating, as the result of surface scouring, is shown in Graph 1, which tells its own story better than can be told in many words.

Wash Water Savings

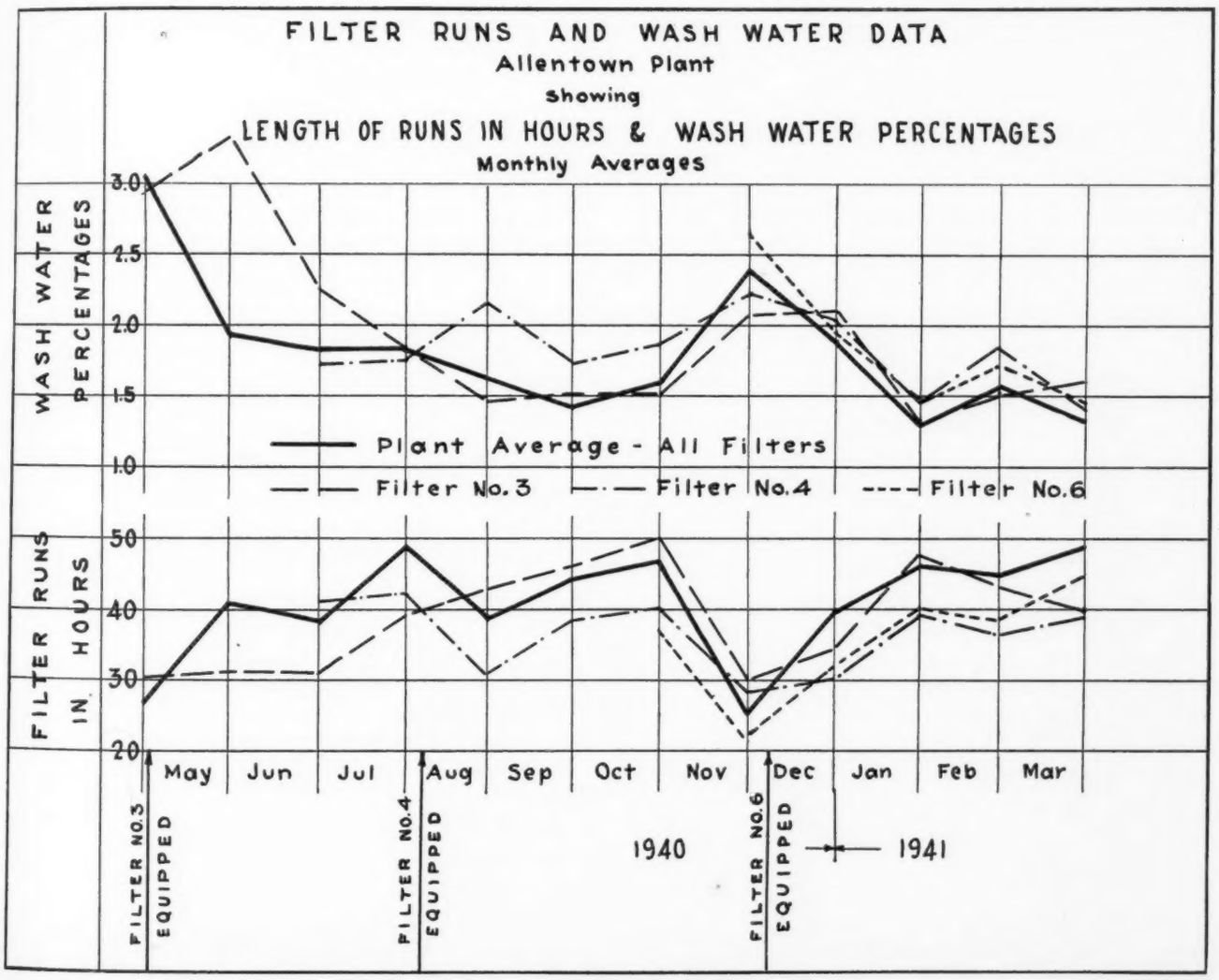
The authors are unable to confirm claims made by others as to marked savings in wash water through the use of surface wash, either by careful analysis of the Allentown plant data or after more general observations elsewhere. It is conceded, however, that other operators may have collected information demonstrating success in this phase of the operations where filter design may not have been as satisfactory as at Allentown.

At Allentown it has been the practice to wash each filter unit at a loss of head of 6 feet, or immediately upon the appearance of turbidity in the effluent of such filter, rather than to depend entirely on the loss-of-head, rate-of-flow, or time period, as variously and generally practiced. Successful coagulation and sedimentation, as well as the turbidity of the raw water, under Allentown procedure greatly affect the length of filter runs. Data on filter runs at the Allentown plant for the year 1940 are shown in Graph No. 2. The effect of spring and fall rains is reflected in the shorter runs in April and November.

In a study of these filter run figures, consideration should be given to the fact that the sand in the plant has been in use for 12 years, and that considerable variation exists in the sizes and uniformity coefficients in the various units because of the gradual and non-uniform loss of the finer particles. The possible effects of these sand characteristics has not as yet been studied in detail.

An examination of the graph on filter runs reveal no definite trend in filter run time, nor does it indicate any reasons for a failure to secure longer runs. The general average of the agitator-equipped filters is approximately that of the other units. The high percentage of wash water used for filters No. 3 and No. 4 in the first months after installation of the agitators in these units, undoubtedly was due to frequent washing for demonstration and experiments, rather than to normal procedure.

From the standpoint of increased length of filter runs, therefore, no savings in wash water have been secured at Allentown. The same general impression seems to have been arrived at in other plants under observation, without any definite figures available for confirmation. A lower sand expansion index has been used at Allentown in the agitator-equipped units than in those not so equipped, but the saving in wash water which appar-



Graph 2—Filter Run and Wash Records

(These Records Fail to Show Wash Water Reduction Accruing from Surface Wash at the Allentown Plant.)

ently should be effected has not been confirmed by actual measurement and plant data.

Chlorine Economy

At Allentown, as previously stated, prechlorination is a regular practice. One of the gains effected through the surface wash installations and a further indication of the increased cleanliness of the media in the units so equipped has been the greater residual chlorine maintained in the effluents of these filters, as compared with the effluents of the remaining filters. Data are shown in Graph 3.

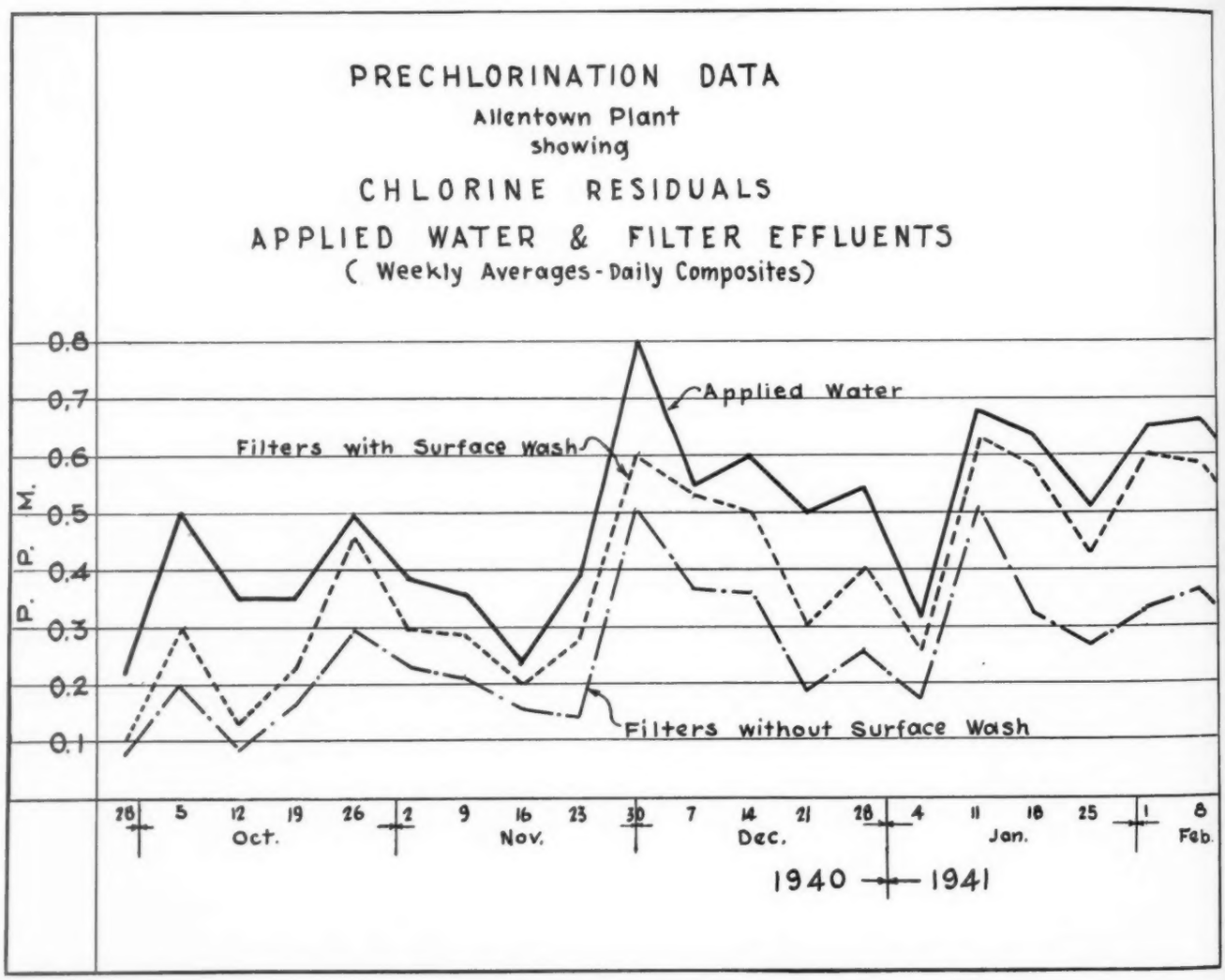
It will be noted that the chlorine residuals in the effluents are uniformly and consistently greater for agitator equipped units No. 3, 4 and 6 than for the other units not so equipped. On many occasions the residual of these units has shown very little reduction from that of the residual of the applied water. In actual practice this means eventually a decrease of appreciable amount in the rate of application of pre-chlorine, with subsequent savings in expenditure for this chemical when all filters have been equipped with surface wash facilities.

This effect of the cleaner sand on chlorine residuals (chlorine absorption by the bed) was first noted in December, 1940, some six months after the first agitator was installed in filter No. 3 and three months after No. 4. Detailed studies and observations on the residuals of the separate units was then begun and have since been continued.

The heavy chlorine demand of the average filter unit is well known, and it is sometimes difficult to secure any residual chlorine through a filter bed unless the sand is super-chlorinated before pre-chlorination is begun, or until heavy pre-chlorination has been practiced for some considerable period of time. As a matter of fact, many an operator has been brought to grief through the application of pre-chlorine to dirty filters because of subsequent severe taste and odor production resulting from reactions between the chlorine and accumulations within the ineffectively washed sand bed.

At Allentown all filters were thoroughly chlorinated before pre-chlorination was begun. Prior to the time the first agitator was installed, application of chlorine in doses up to 1.14 lbs. per million gallons had been used continuously for approximately 12 months, with the point of application at the influent of the mixing chamber, approximately three hours before the chlorinated water reached the filters.

The decreased chlorine demand of the filtering media after the agitators were installed became apparent almost immediately in filter No. 6, and after about two weeks of operation, the residual of this unit reached



Graph 3—Records of Chlorine Removal by the Filters

(Indicating the Extent to Which Chlorine Is Absorbed by Coated Sand vs. Clean Sand in Those Filters Equipped with Palmer Agitators—in Itself an Index of Sand Cleanliness as Well as an Operating Economy Realized.)

approximately the same figures as for those of filters No. 3 and 4, which had been surface washed for about 6 months and 4 months, respectively, prior thereto.

The authors hope to make a detailed study of this problem—the chlorine demand of filter media—in the near future.

Costs of Installation

The effective apparatus of the agitators, consisting of a toggle joint, pipe manifold, and special nozzle openings, all of brass, was purchased at a cost of $197.64 for each unit at Allentown. Auxiliary valves and pipings were purchased by the city and installed by the salaried employes of the city. Basing the labor costs, however, on current hourly rates for skilled mechanics, and adding in the costs of piping, valves, etc., the total cost of installation for one unit (1.25 m.g.d.) was $310. This would mean a total cost of about $2,500 to equip all eight filters in the plant.

In this cost analysis, consideration must be given to the fact that the Allentown filter boxes are almost square in plan (20 by 22 feet), so that it was possible to use only one revolving mechanism to each unit. With filters of dissimilar area, the costs may be greater because of the necessity for installing two or more arms in each bed to cover the entire area. Apparently a reasonable average cost figure, for general use, might be given as $350 per M.G.D. of filter capacity.

Summary

1. To a greater or lesser degree, mud-balls and hard spots are common to rapid sand filter units.

2. Despite careful design, careful operation, and a multitude of practices, no generally successful method of preventing these disturbances had been found prior to the development of the surface wash by Baylis about 1930.

3. In all plants where surface wash has been made an auxiliary to normal bottom wash, improvements in the appearance and cleanliness of filter media have been made.

4. Surface wash piping or the revolving Palmer agitator can be installed without any major interference with normal filter operation.

5. Costs of installation of the Palmer Agitator depends on the size and shape of the filter boxes, but generally speaking, should average about $350 per M.G.D. capacity, including all costs for labor and appurtenances.

6. At Allentown, Pa., with a Palmer Agitator to provide surface wash:

a. Mud balls were practically eliminated in five weeks' operation of a full scale unit.

b. Coating on sand grains was materially reduced.

c. No appreciable saving in wash water has resulted through the use of surface agitation.

d. With pre-chlorination, the effluent of agitator equipped filter units show continuously higher chlorine residuals than do the units washed at high rates but without surface agitation.

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Sludge Solids by Centrifugal Method

Simplified Formulae Suggested and a Correction

By G. E. SYMONS
Chief Chemist, Buffalo Sewer Authority

IN THE March issue of WATER WORKS AND SEWERAGE, pp. 106-108, the Bird Island Laboratory of the Buffalo Sewer Authority presented the results of experiments on the estimation of total solids in sewage sludges by centrifuging. The two formulae were proposed for converting the centrifuge solids, expressed as per cent by volume, to per cent total dry solids. Unfortunately, these formulae were interchanged in the original manuscript. This transposition was detected too late by all concerned to get a correction in the April issue of WATER WORKS AND SEWERAGE. The correct formulae should read as follows:

A. For *Raw Sludge*

Ratio of % Cent. Solids to % total solids = 2.7 + (% Vol. Mat. — 40.0) × 0.06

or

$$\%\ \text{Total Solids (by weight)} = \frac{\%\ \text{Cent. Solids by Vol.}}{2.7 + (\%\ \text{Vol. Mat.} - 40.0)} \times 0.06$$

B. For *Digested Sludge*

Ratio of % Cent. Solids to % total solids = 2.7 + (% Vol. Mat. — 35.0) × 0.09

or

$$\%\ \text{Total Solids (by weight)} = \frac{\%\ \text{Cent. Solids by Vol.}}{2.7 + (\%\ \text{Vol. Mat.} - 35.0)} \times 0.09$$

Simplified Formulae

This very evident transposition was first called to our attention by Mr. Arthur B. Morrill, Engineer of Sewage Treatment at Detroit, Mich., who at the same time suggested that these two formulae could be condensed as follows:

A. For *Raw Sludge*

$$\%\ \text{T. S.} = \frac{\%\ \text{C. S.}}{0.06\ (\text{V} + 5.0)}$$

B. For *Digested Sludge*

$$\%\ \text{T. S.} = \frac{\%\ \text{C. S.}}{0.09\ (\text{V} - 5.0)}$$

Where V is per cent volatile matter. (TS) being total solids and (CS) centrifuge solids.

In reference to the use of this method and these formulae, a criticism received is that the spread between maximum and minimum results indicates that a single determination may be as much as 20 per cent in error. An inspection of the individual data shows that these spreads have appeared, but represent occurrences approximately only 5 per cent of the time. For the majority of the observations, the possible error appears to be within 10 per cent.

The Bird Island Laboratory is now developing another method for the rapid estimation of sludge solids and this method will be published in an early issue of WATER WORKS AND SEWERAGE.

WATER HAMMER CORRECTIVES

By RICHARD BENNETT,
Hydraulic Engineer,
City Engineer's Office,
PHOENIX, ARIZONA

THE term "water hammer," which is incorrectly used for the term "water surge," has become so common in water works language that no attempt will be made herein to refer by other words to this annoying phenomena, which oftentimes proves to be a difficult and costly problem.

Failure of pipe joints, hot water heaters, pumps and similar equipment are all evidence that destructive water hammer is undermining the efficiency or dependability of many water supply lines or plumbing systems.

Pipe lines subjected to sudden shock or recurring vibration due to water hammer, become weakened and operate inefficiently. As is shown in Fig. 1, this destructive nuisance may also pull pipe hangers loose or create damaging leaks.

Destructive water hammer may actually be present in water lines even where its presence is not indicated by violent hammering and noisy vibration. For the most part this fact is not generally realized or recognized.

Cause of Water Hammer

If flow in a pipe is suddenly stopped, the energy built up by the flowing water produces a high pressure which may result in a terrific impact. This is caused by the non-compressible liquid (water) rebounding in the supply lines. This rebound impact is due to the sudden stopping of water flow every time a faucet or valve is closed. Power for operating hydraulic rams, which force water many times higher than the static head on the power water supply line, is thus generated by intermittent quick closures of valves attached to the ram.

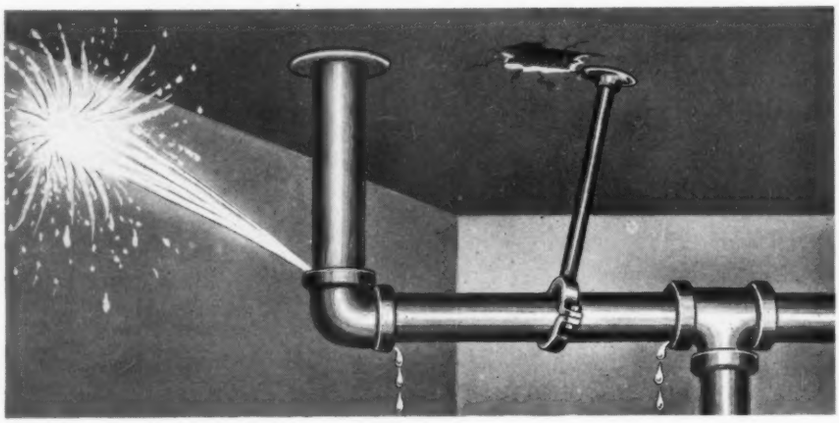


Fig. 1—A Pipe Line Subjected to Sudden Shock and Continual Vibration Caused by Surge and Water Hammer.
(Eventually Leaking Joints Develop to Do Costly Damage.)

In order to have conception of this force in small pipe, when water hammer occurs the pressure is increased by about 60 pounds per square inch above the flow pressure for each foot per second of sudden decrease of velocity of flow. This means that if a flow velocity of 10 feet per second is stopped instantly, a maximum water hammer pressure rise of (10x60) 600 lbs. per square inch may occur. This pressure is added to the normal static pressure at the point of impact.

Destructive water hammer must be eliminated to avoid the nerve-racking noise from which the term is derived; to reduce stress in the pipes; to safeguard plumbing fixtures; to avoid costly leaks and repairs; and to prevent operating delays.

Here is a readily comprehended discussion of the cause and effects of pipe line surge—popularly termed "water hammer"—and a highly useful review of practical and proven correctives and equipment which has demonstrated merit for the purpose offered.

This topic, originally presented by the author in the form of an illustrated talk before the Arizona Sewage and Water Works Association, proved so informative and well received that we prevailed upon Mr. Bennett to put it into form for publication.

The author, in submitting this review, states, "As one reads this paper and looks at the catalog type of illustrations employed, it will be realized that this talk was nothing more nor less than a good, plain plug for the manufacturers of the equipment referred to. However, the selection of equipment mentioned by name was only because much study and investigation prior to the talk had led me to actually know that these manufacturers sold dependable equipment, and no apologies were necessary. While there are without doubt other manufacturers who sell dependable equipment for water-hammer elimination, I am not yet familiar with them. And, knowing that our members wanted something just as practical as possible, I chose this scheme of presenting the topic in a practical way."

Mr. Bennett further comments that essentially all of his material was already available to those who would gather together the existing catalogs of the several manufacturers and take the time to study them. However, water works men are kept pretty busy, and Mr. Bennett, we think, has performed a valuable service in bringing together in a few pages information obtainable only by search through catalogs and bulletins of the several widely scattered manufacturers.

This highly useful and informative review of methods and equipment, which have proven worthy as line surge and water hammer correctives, represents a type of article which should, in our opinion, appear more frequently in the technical publications.—L. H. E.

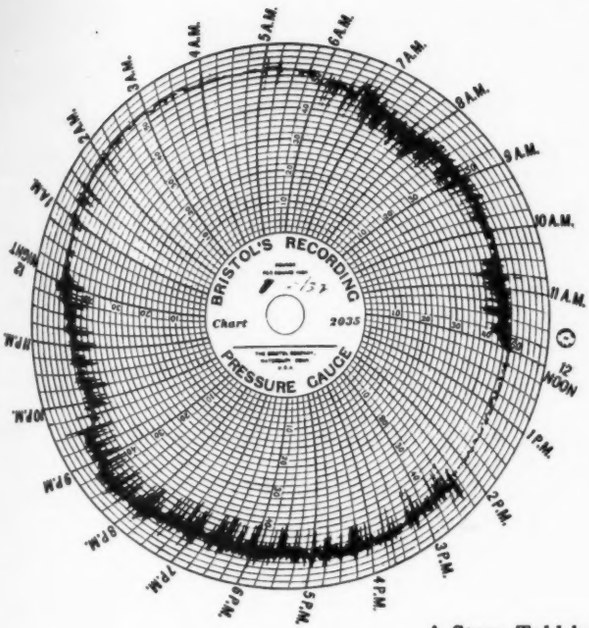
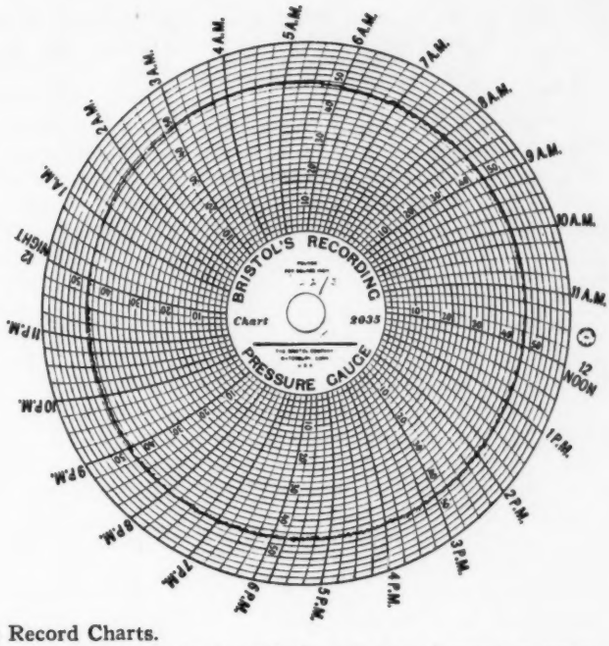


Fig. 2—Reveals the incessant impact shocks and fluctuating pressures when water hammer is present.



A Story Told by Two Record Charts.

Fig. 3—After the installation of a good surge suppressor the record chart should look something like this.

Correctives

Relief from destructive water hammer may be accomplished by relief valves, but these can be used only in special cases. Relief can be obtained by air chambers, but the difficulty of keeping air in the chamber makes this method impractical under many conditions of operation. In many instances positive and permanent relief can be obtained by the installation of surge suppressors. These are sometimes given trade names such as shock absorbers, water hammer arresters, etc. Just as the automobile shock absorber absorbs the bumps of the highway, so does a good surge suppressor cushion the terrific impact of water rebounding in the piping system.

Unless a surge suppressor is installed, the water backs up with terrific force and continues to bound and rebound in the pipe lines every time the flow of water is suddenly checked. With a good surge suppressor this pounding and hammering is

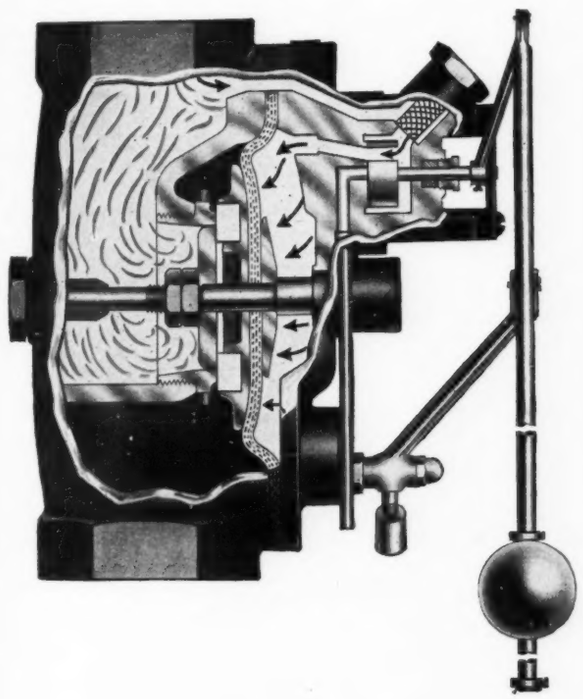


Fig. 4.—The Clayton Valve—Closed Position

Is a quick closing valve designed to preclude hammer by uniform and governed rate of closure.

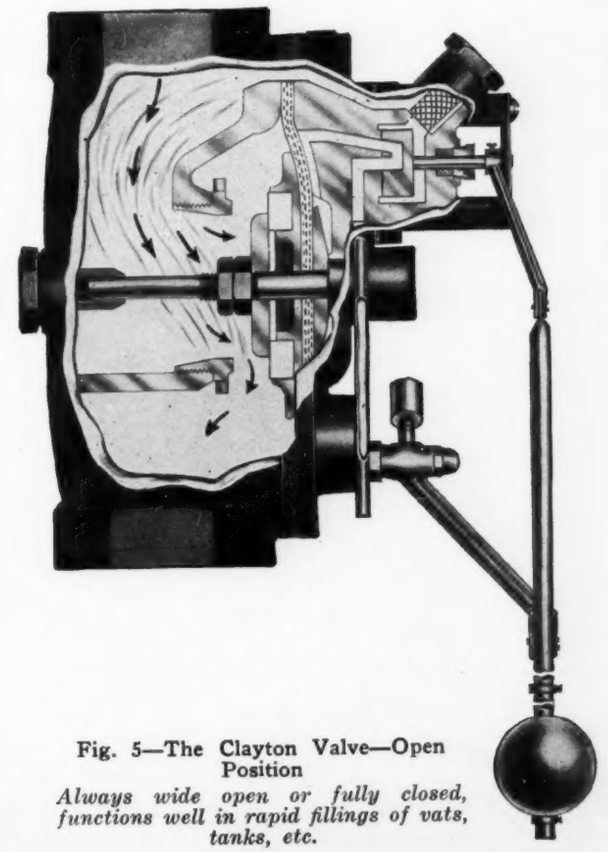


Fig. 5—The Clayton Valve—Open Position

Always wide open or fully closed, functions well in rapid fillings of vats, tanks, etc.

overcome by absorbing and dispelling the shocks, and strain in the pipe is relieved.

In selecting a surge suppressor it is desirable that it afford protection from water hammer under all conditions of service; that it be easy to install; require no periodic adjustments; require little or no maintenance; that it operate in any position; that it be unaffected by hot water; and that it be reasonably priced.

Under some conditions it is possible to determine in advance the behavior of the surge suppressor, and a method for calculating the degree of relief from water hammer pressure for a given piping layout is obtained by the relation between useful volume of air in the surge suppressor for the various rates of discharge through the pipe line.

Theoretical considerations are generally to assume the discharge suddenly stopped by valve closure. This seldom occurs in actual practice. The size of the surge suppressor to be selected for each installation should be adequate to reduce the maximum water hammer pressure that can be caused by quick closure of any one valve or faucet.

In Fig. 2 is illustrated the action of water hammer as recorded on a time-pressure diagram showing the incessant impact shocks and pressure fluctuations. The system is free of this shock effect (even though hammering may not be heard) only during those hours when no water is being drawn.

When an efficient surge suppressor is installed the time-pressure chart recording should look something like the chart shown in Fig. 3. A proper suppressor will quiet the water hammer by dissipating impact shocks and overcoming the pressure fluctuations.

Surge Suppression Devices

Perhaps you have come to the conclusion of "Why not eliminate the source of the water hammer?" Quick closing valves are the cause of most of this trouble, but modern equipment of the present day increasingly requires quick closing valves and water customers insist on quick closing faucets and fixtures, therefore water hammer troubles may be expected to increase, rather than decrease, in the future in most water works.

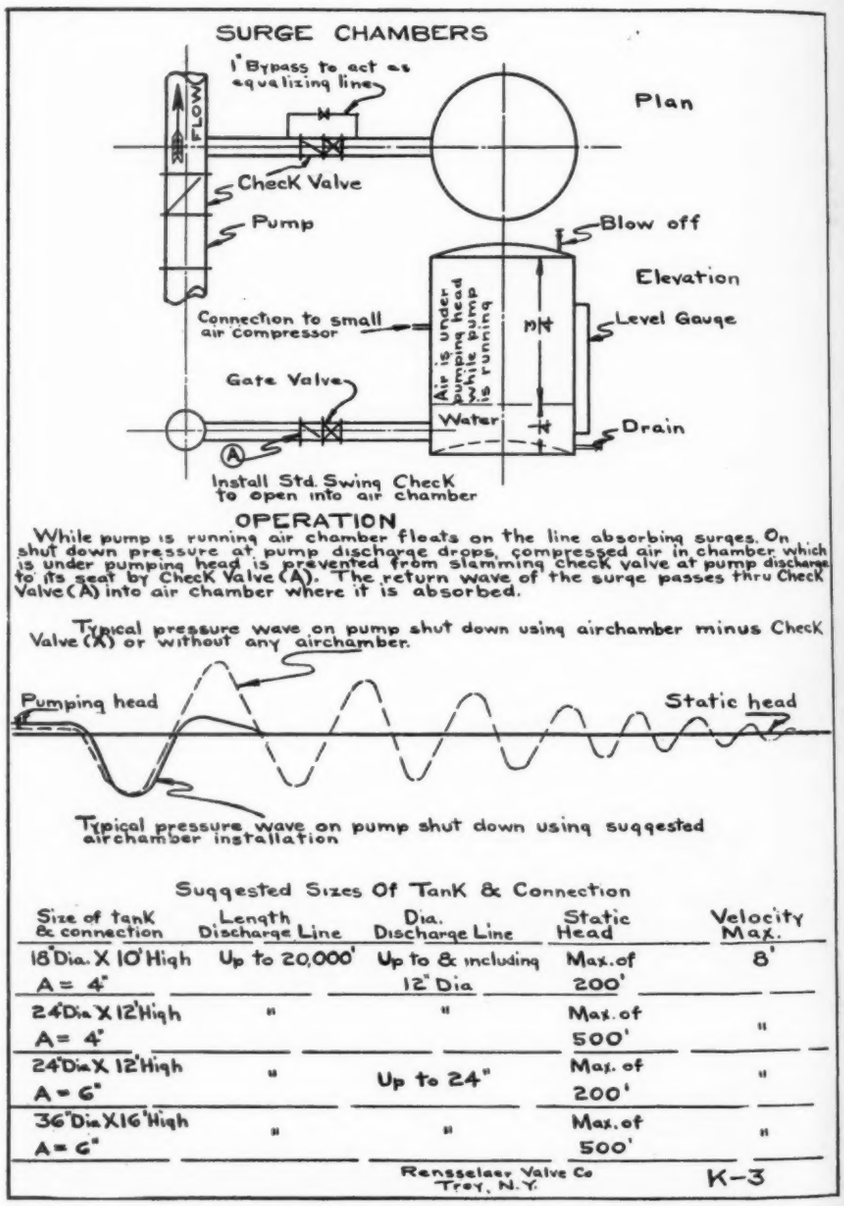
Valve manufacturers, as a group, have done very little to produce equipment to meet this situation, however, the Clayton valve has been designed for this purpose. It can be adapted to almost any type of flow control problem. Figs. 4 and 5 show this valve in the closed and open position. The arrows show that the valve is kept closed by water pressure on the back of the diaphragm. This valve can be furnished with an adjustable needle control for regulating the closing speed to meet any given condition. The illustrations given here show float control for rapid tank filling and smart shut off, but the manufacturer states that it can be adapted to remote, automatic, manual, electric, or any type of control desired. Fig. 5 shows that when pressure behind the disc is removed the line pressure forces the diaphragm assembly away from the seat. This valve is always wide open or fully closed, and closes at a governed uniform rate to eliminate line shock when the shut-off occurs.

Relief Valves

Relief valves are sometimes used to eliminate water hammer but they can be used only in special cases, due largely to the spill of water which must be cared for, and do not operate except under high surge pressure. However, many have secured satisfactory results from these devices at pumping stations and hydroelectric plants where water spill is not a problem.

Air Chambers

Relief from destructive water hammer may be accomplished by air chambers, but the difficulty of keeping air in the chamber makes the air chamber impractical, unless given close attention, or air recharging can


SURGE CHAMBERS
1" Bypass to act as equalizing line
FLOW
Plan
Check Valve
Pump
Blow off
Elevation
Connection to small air Compressor
Air is under pumping head while pump is running
Level Gauge
Gate Valve
Water
Drain
A
Install Std. Swing Check to open into air chamber
OPERATION
While pump is running air chamber floats on the line absorbing surges. On shut down pressure at pump discharge drops, compressed air in chamber which is under pumping head is prevented from slamming check valve at pump discharge to its seat by Check Valve (A). The return wave of the surge passes thru Check Valve (A) into air chamber where it is absorbed.
Typical pressure wave on pump shut down using airchamber minus Check Valve (A) or without any airchamber.
Pumping head
Static head
Typical pressure wave on pump shut down using suggested airchamber installation

Suggested Sizes Of Tank & Connection

Size of tank & connection	Length Discharge Line	Dia. Discharge Line	Static Head	Velocity Max.
18" Dia. X 10' High A = 4"	Up to 20,000'	Up to & including 12" Dia	Max. of 200'	8'
24" Dia X 12' High A = 4"	"	"	Max. of 500'	"
24" Dia X 12' High A = 6"	"	Up to 24"	Max. of 200'	"
36" Dia X 16' High A = 6"	"	"	Max. of 500'	"

Rensselaer Valve Co Troy, N.Y. K-3

Fig. 6—Air Chamber Assembly and Design Data for Surge Suppression in Centrifugal Pump Operation

Courtesy Rensselaer Valve Co.

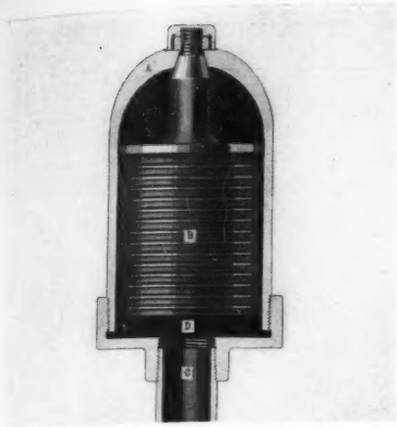


Fig. 7—"Wacor" Water Hammer Arrester

Position of bellows compression unit at time of normal pressure.

be automatically done with compressors.

Fig. 6 illustrates an air chamber assembly. When the pump is running the chamber of compressible air floats on the line absorbing or cushioning surges. When a pump shuts down pressure at the discharge drops instantaneously and then the back surge follows. Compressed air in the tank, which is under pumping head, is prevented from slamming the check valve on the pump discharge line to its seat by the functioning of check valve (A). The return wave of the surge, however, can pass through the check valve (A) into the air chamber where it is markedly cushioned and gradually absorbed during gradually diminishing surges.

For most all cases of water hammer, of the type caused by quick closing valves on all but the largest lines, a surge suppressor which may be attached to the pipes and operate automatically without maintenance is to be preferred. Of this type the "Wacor," shown in Figs. 7 and 8 is very reliable. This suppressor has been thoroughly engineered for small piping systems, the manufacturer having financed an extended research program in the hydraulic laboratories of the University of Wisconsin, where all possibilities of this equipment were rather thoroughly explored.

"Wacor" Water Hammer Arrester is manufactured in a number of sizes for pipe lines up to 10-inch in diameter. It is a combination mechanical-pneumatic type of absorber constructed with a closed metal bellows or compression compartment. The latter is filled with a special compressible emulsion so that air can neither escape nor be absorbed by the water. It is particularly adapted to all ordinary house services where water hammer exists or where high pressures engendered by rapid valve closure are damaging piping and fixtures.

When this suppressor is put on the line the sealed compression chamber or bellows (containing the emulsion) is slightly compressed as the water pressure is turned on the system. This is shown in Fig. 7, with the bellows at resting position. If now a valve or faucet is opened and water flows through the pipe, the bellows expands somewhat due to the reduction of the pressure at its base. As the valve or faucet is closed the velocity of the water in the pipe line is reduced, resulting in an increase of pressure. This compresses the bellows, resulting in an increase of pressure on the emulsion sealed within the bellows. The pressure inside and outside of the bellows thus become equalized. Work done in compressing the fluid emulsion within the bellows is responsible for the absorption or damping of the hammer pressure in the pipe line to which the arrester is

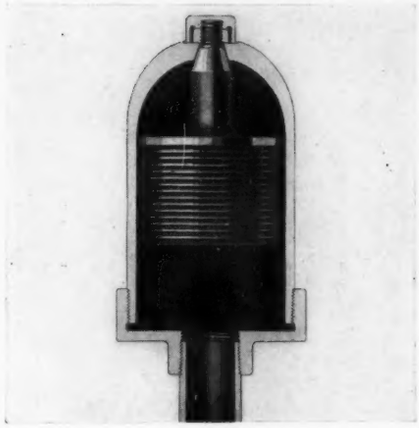


Fig. 8—"Wacor" Water Hammer Arrester

Position of bellows compression unit when absorbing hammer shock.

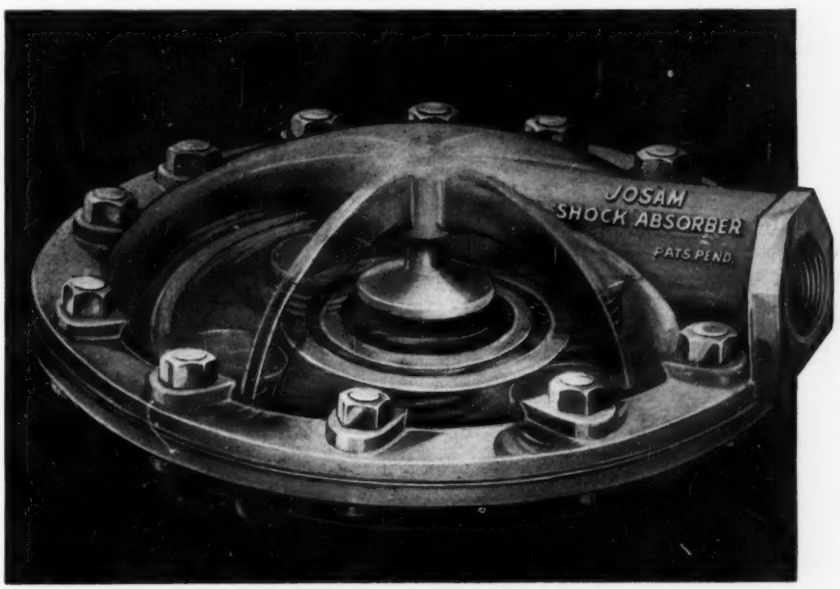


Fig. 9—The Josam Shock Absorber

Phantom view showing four coil springs in dry side of diaphragm chamber, which absorbs and dissipates the shock.

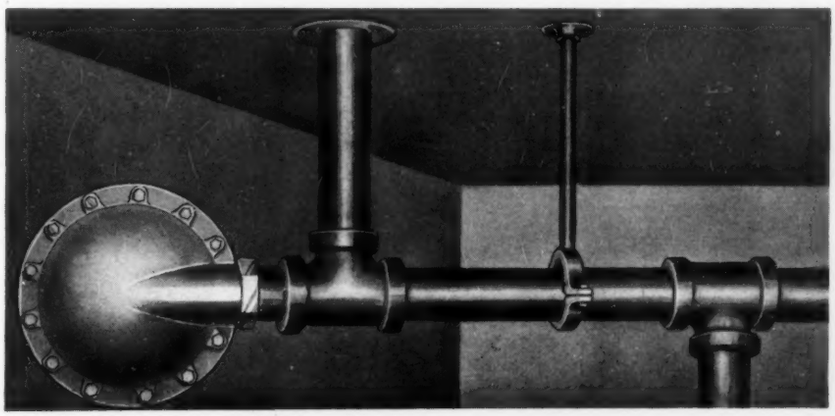


Fig. 10—A Josam Shock Absorber

(*Installed at typical location point on the end of a long straight run of pipe.*)

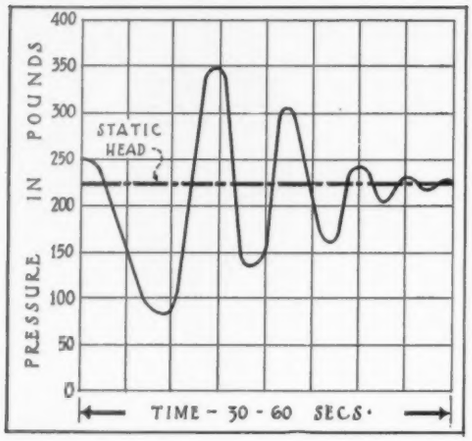


Fig. 12—The Effects of a Slow Closing Check

The lag in closing is responsible for the marked surge and hammer pressure.

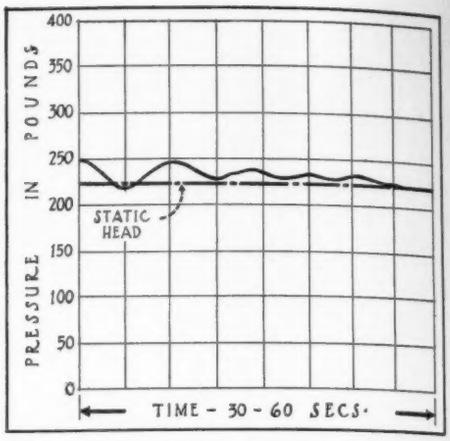


Fig. 13—The Effects of a Quick Closing Check

Showing the results of rapid closure when effectively timed ahead of the first rebound of the water column.

connected. This is shown in Fig. 8, and illustrates the position of the bellows when absorbing the hammer shock.

This type obviates the need for the attention which air chambers require. They are used with quick action valves and high velocities of flow, and can be used where water hammer pressure originates in the municipal distribution system and affects the consumers' service line or plumbing installation.

Another surge suppressor for small piping systems is the Josam Shock Absorber, which is shown in Fig. 9. It operates on the diaphragm principle and is very efficient when properly sized to the individual problem. This suppressor absorbs shock by compression of four coil springs very much after the manner of the coil springs known as Knees in modern automobiles. The diaphragm moves out against these springs located on the dry side of the unit.

Location of Suppressors

Practice varies widely as to the proper installation point for surge suppressors; some will place a suppressor at the end of all long runs of pipe; others install at the end of a battery of fixtures, but it seems agreed that it should be placed *as near to the valve causing the water hammer as is permissible.*

It is desirable to place the suppressor so that the opening is at the bottom if possible. This will avoid hazards from sediment being washed into the casing. Wherever a greater capacity is required to reduce water hammer pressure than can be furnished by a single suppressor, any number can be placed in the pipe line, either in scattered positions or together at one fitting.

Figs. 10 and 11 show typical installation points for suppressors of this general type.

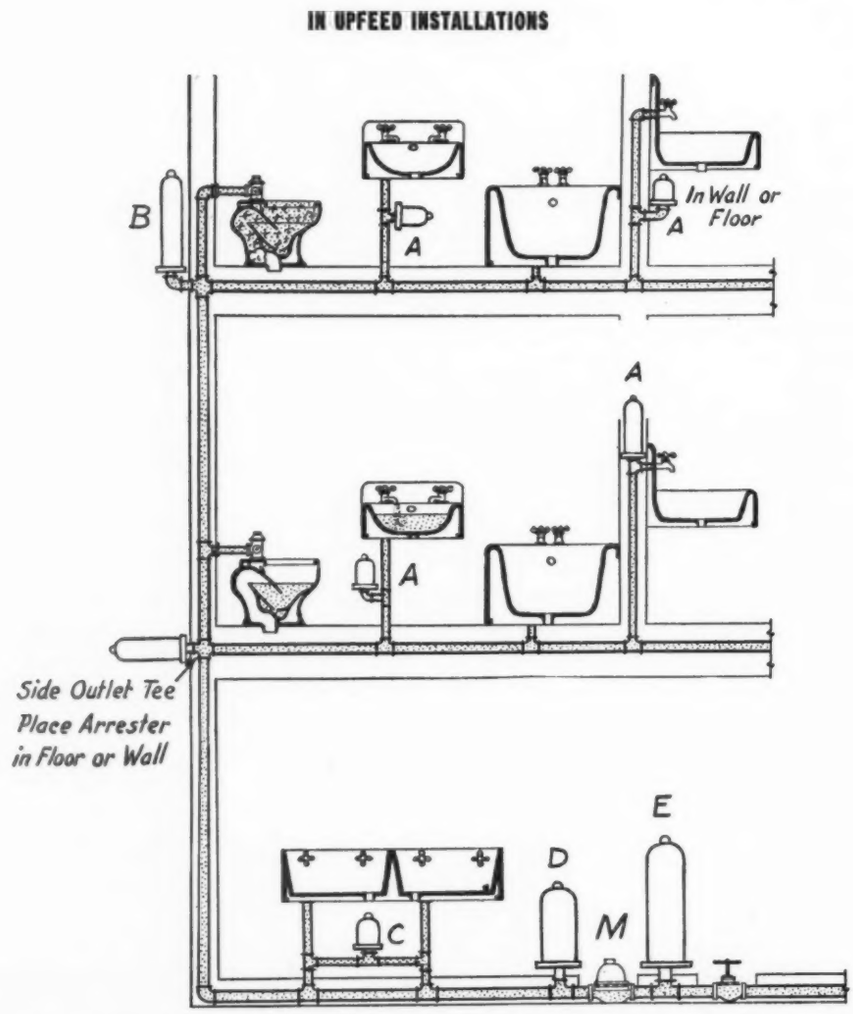


Fig. 11—Illustrating Other Typical Location Points for Shock Absorbers and Hammer Arresters

Water Hammer with Centrifugal Pumps

The use of centrifugal pumps presents a major problem in the control of surge waves and minimizing of water hammer. When the power is shut off the water in the discharge line reverses its direction of flow and if not controlled will cause reversal of pump and motor.

The installation of the flap type check valve with centrifugal pumps increases the effect of surge waves and water hammer, if not actually being responsible for such. Ordinary check swing valves, due to slamming, cause abnormal disturbances in the pipe lines. Slam leads to serious trouble because of the resulting vibration of pipe lines and adjacent structures, opening up the pipe joints. The resultant water hammer frequently ruptures the pipe line. The common swing check valve is

Fig. 14—The Smolensky Check
A wholly mechanical valve

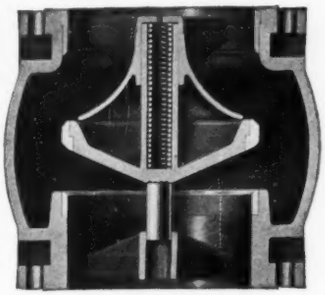


Fig. 15—Interior of the Smolensky Check
Spring force enables this valve to close slightly in advance of cessation of flow away from the stopped pump.

fundamentally wrong in its design to be of use for such service.

Check valves may be grouped into two general classes: (a) slow closing and (b) quick closing.

Most slow closing valves are, however, impractical, even though theoretically correct. The action of this type of valve with respect to water hammer may be shown by the illustration in Fig. 12. In practice there may be little or no audible water hammer with this type, but as indicated, there is a serious pressure rise due to the surge which may be disastrous to the pipe lines and fittings.

A check valve should generally be of a type that closes *before* the pressure reverses from the immediate low to the quickly ensuing high. Many have found that this is the only type that will give proper service. The quick closing check valve provides for eliminating surge shock at the valve seat, and quickly returns the surge wave to static pressure before any appreciable surge oscillation can be set up in the discharge line. All discharge lines, especially of the larger diameters, are at least to some degree elastic and will permit so-called harmonic surges to develop. When the discharge column of water is halted before a reversal of flow takes place, these surges will not

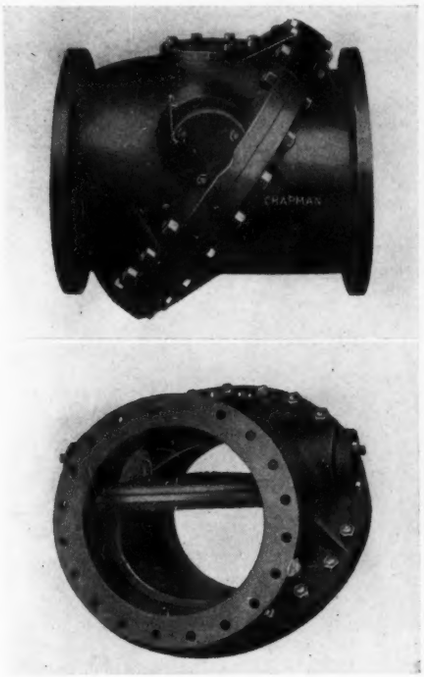


Fig. 17—Chapman's "Non-Slam" Check
Features the streamlined tilting disc, closing gradually to completion at instant of flow cessation away from pump.

cause a dangerous pressure rise. The action of the rapidly closing type of check valve, with respect to ensuing water hammer, may be illustrated as shown in Fig. 13. These two pressure recordings (Figs. 12 and 13) show that the pressure rise has been reduced from about 50 per cent excess head to about 10 per cent over the static pressure through the effective timing of closure of the automatic check.

The Smolensky Check

One type of check valve used for this purpose is the Smolensky check valve, which is illustrated in Figs. 14 and 15. This valve is designed to close just a little in advance of minimum pressure at the pump, so as to insure absolute freedom of danger of reversal of pump and motor. It also prevents mechanical shock at the check valve for the spring action is counterbalanced by the back pressure against the diminishing pump discharge. The mechanism of this valve is shown in Fig. 15.

The seat position of the Smolensky valve is dependent entirely upon the velocity of the flow and the action may be understood by reference to the homely analogy of a laborer following a loaded truck up a steep incline. By chocking the wheels at the slightest tendency to stop, a small stone is sufficient to hold the load from reversing. Allow the truck to fall back a few feet and the truck load will be in danger, since its stopping is much the more difficult.

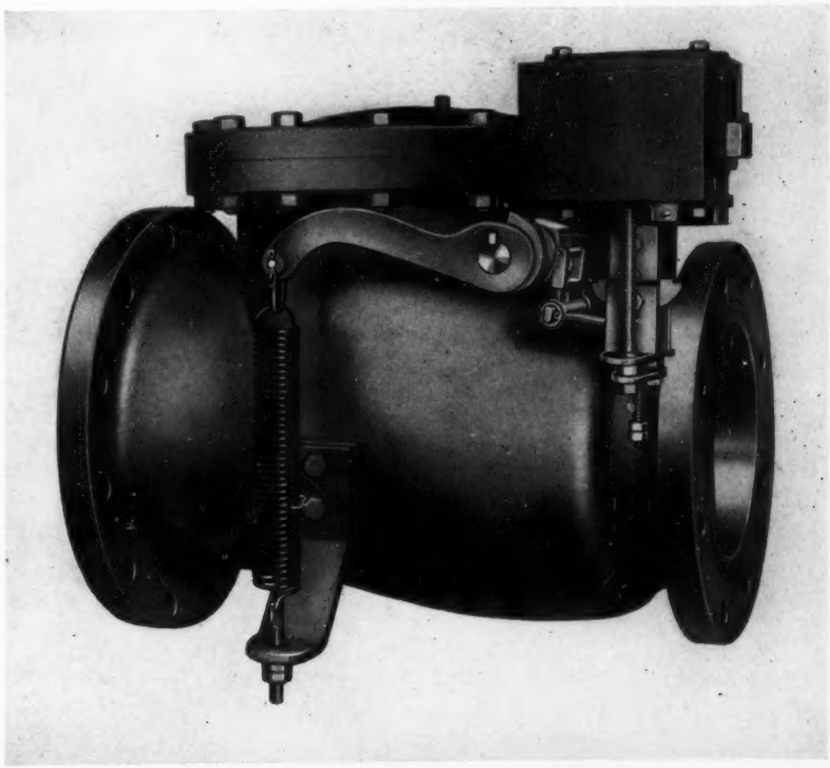
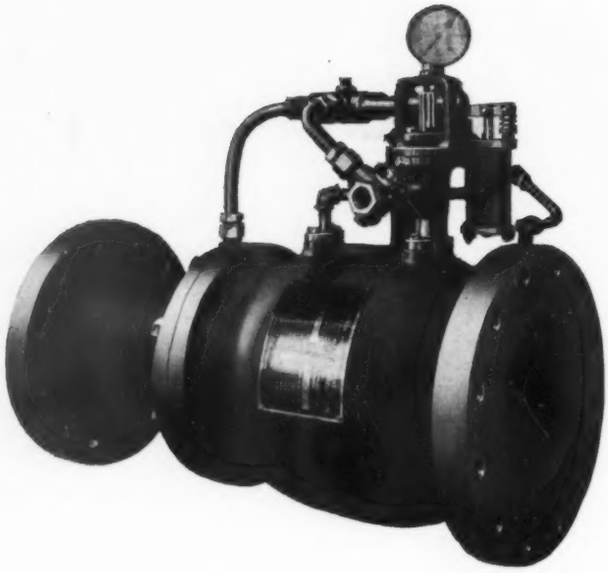


Fig. 16—The Rensselaer Automatic Power Check
Features low-friction clear-way and quiet spring loaded closing of the flap ahead of cessation of flow away from the stopped pump.



Pelton's Larner-Johnson Check Valve

Fig. 18—Exterior of this automatic needle-type check.

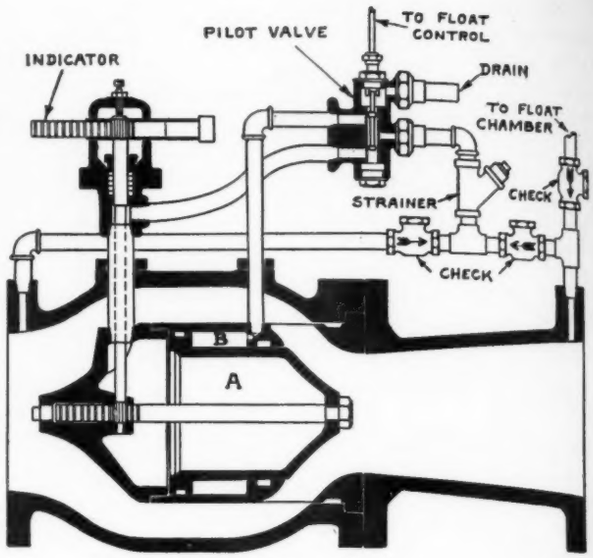


Fig. 19—Sketch revealing design and functioning of the valve.

Fig. 20—The Pelton Surge Suppressor
A high grade relief valve for use in conjunction with automatic check valves.

Rensselaer's Power Check

Fig. 16 shows the Rensselaer quiet-closing power check valve. This check operates with an electric solenoid. When the pump is started the swing check is opened and held out of the flow in a locked position. Instantly that the power is released the solenoid automatically releases the swing check and the power of the spring instantly closes the check ahead of the reversal in direction of flow.

Chapman's Tilting Disc

Fig. 17 illustrates the exterior and interior of the Chapman non-slam tilting-disc check valve. This type of check closes with a minimum of slam and friction losses are also very substantially reduced in the design. The disc is pivoted just above its center, which results in a cushioning effect resulting while closing. This is due to the fact that the portion of the disc above the pivot partially balances the portion below. The seat and disc rings are beveled and the disc drops into the seat in the body with a closing action which gives a further cushioning effect. This valve in closing reaches its seat at exactly zero velocity in the line. The angle of the seat is so incline that the distance the disc must travel from its wide open position to its seat is reduced to the minimum consistent with good design.

Larner-Johnson Check

Fig. 18 shows the exterior of the

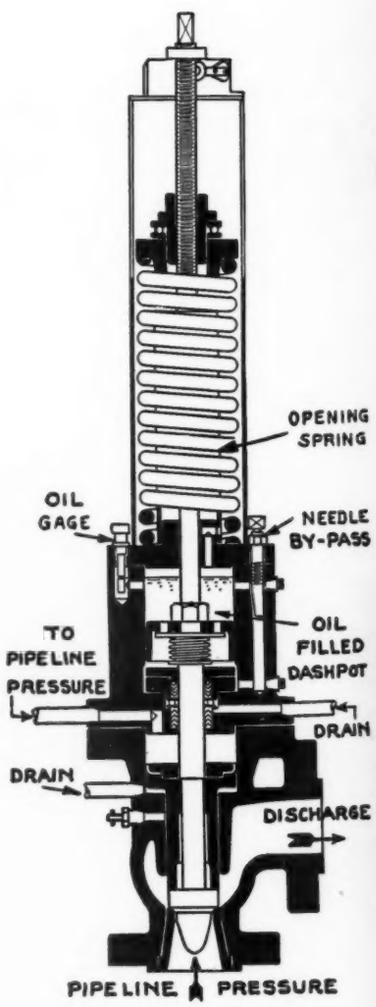


Fig. 21—The Pelton Surge Suppressor
Sketch revealing working parts and functioning of this surge dissipating unit.

Pelton-Larner-Johnson check valve, and Fig. 19 shows how it functions.

This check is normally automatic in operation but may be arranged for manual control. With the control equipment which is built into this type of check valve the time of closing may be regulated to best suit local conditions. It is designed for installation on the discharge side of a centrifugal pump, its best function being to close at the instant of power failure and to prevent both reversal of the pump and motor and wastage of pumped water.

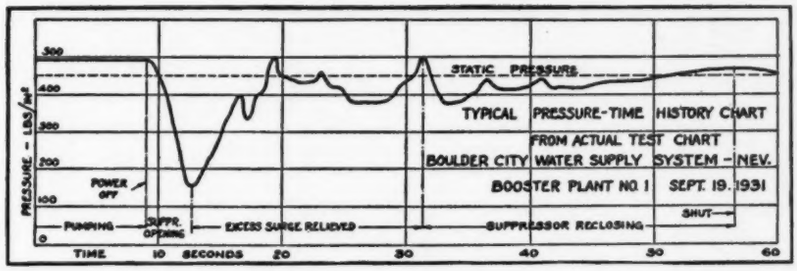


Fig. 22—A Real Performance Record
Showing the result of combination of automatic check and Pelton Surge Suppressor on a heavy duty job under 490 lbs. static head. This race was won in approximately 50 seconds flat.

Pelton Surge Relief Valve

In many cases of operating centrifugal pumps, surge and water hammer cannot be eliminated by the mere installation of a check valve alone regardless of type. In such cases it is also necessary to install additional equipment such as an air tank, relief valve or such. For difficult situations one of the best known pieces of equipment for this purpose is the Pelton Surge Suppressor, shown in Figs. 20 and 21. This surge suppressor is essentially a high grade relief valve, designed for use with a check to relieve surge pressure in a pump discharge line incident to pump shutdown. It may be operated either by water pressure, solenoid, or mechanical interconnection with the check valve. To permit a sufficiently rapid closure of the check, and thereby prevent dangerous reversal of the pump after the power shut-off, the surge suppressor is essential to relieve the resulting pressure surges. The surge suppressor *opens with the drop in pressure* following shutdowns, remaining open to relieve the surge which follows. It then automatically closes at an adjustable rate.

The action of the Larner-Johnson Check Valve and the Pelton Surge Suppressor in combination are shown in the results obtained on the accompanying time-pressure diagram (Fig. 22) of the Boulder Dam water supply to Boulder City. Operating under a static pressure of about 490 pounds, the time-pressure diagram (Fig. 22) shows that it took about 50 seconds only for the pressure head to become normal static head after pump shut-down during which interval the rise in pressure was not more than 10 pounds above static.

Studying and Recording Surge Conditions

In actual operating practice it is seldom that any two cases of surge or water hammer are identically alike. The simpler cases of surge in building pipe systems may usually be overcome with the low cost type of surge suppressors previously shown. With the more complicated cases, especially those affecting water distribution systems, the conditions become very involved and it is usually necessary to make a complete survey of the actual facts pertaining to each individual case before it can be properly handled. It is necessary to determine the amount and intensity of water hammer and thereafter take new records in order to determine the results obtained from equipment installed, or other corrective measures applied.

For this purpose it is essential to employ equipment for recording pressure-time diagrams of the disturbance. Fig. 23 shows Bachrach's Chronomatic Drum which gives a pressture-time diagram, revealing clearly the pressure pulsations in the pipe line during a certain time interval. Fig. 24 shows this equipment in carrying case, for ready portability. This is a time-pressure indicator originally designed for testing high-speed diesel engines. It has unrestricted speed selectivity and instantaneous speed indication. The operation is simple and requires no skill or special training. The time-pressure diagram for the Boulder City line was taken with this equipment.

Few engineers have had wide contact with problems calling for relief from water hammer in pipe lines or piping systems. The present literature on the subject is neither broad nor inclusive, being largely devoted to the extreme technical and theoretical phases of the subject. On this account it has been my purpose to confine this discussion to a few practical considerations and solutions, which might be encountered in and applied to any water works or plumbing system.

[*Acknowledgement*: *Mr. Bennett's paper is based on what proved to be a most interesting and informative illustrated talk made by the author before the Arizona Sewage and Water Works Association.*]

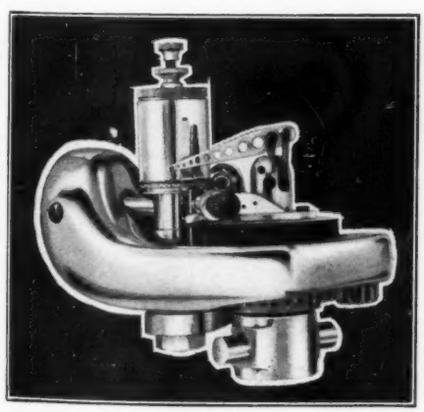


Fig. 23—Bachrach's Chronomatic Drum
Its use provides the all important time-pressure chart in studying water hammer and attainments resulting from corrective measures and functioning of equipment.

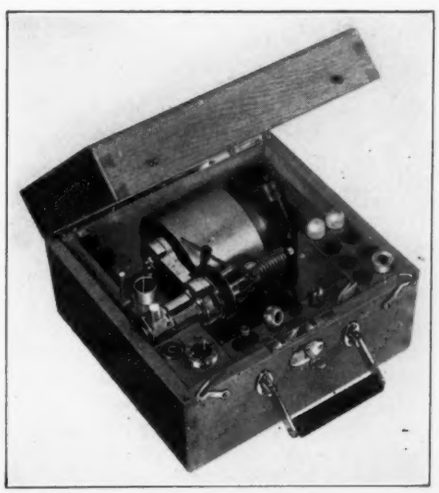


Fig. 24—Bachrach's Portable Recorder
Is compact and useful in surge study on pipe lines and distribution systems.

ACTIVATED SLUDGE AT ROCKVILLE CENTRE*

And How We Tame It

By C. GEORGE ANDERSEN
Superintendent, Sewerage and Sewage Treatment
ROCKVILLE CENTRE, LONG ISLAND

IN THE business life of a Sewage Plant Operator there are many interesting things to talk about, but to me the biological subject has been the most interesting. Many types of plants are definitely mechanical, but in the biological activated sludge process we have a worthy opponent to wrestle with.

This paper may be an answer to the query made editorially some time ago by Linn Enslow, Editor of WATER WORKS AND SEWERAGE, on the progress made in the field after papers have been given on a plant subject. The Rockville Centre Plant, being one of the early activated sludge installations, there naturally were a lot of kinks to be ironed out. Little was known of the sludge except that it treated sewage biologically. Bulking and its companion, low solids content, in sludge to be placed in digestion tanks, were the prime trouble makers in both cycles of the treatment, sewage purification and sludge digestion.

The troubles which we have encountered have been covered quite thoroughly in articles published in the *Sewage Works Journal*, particularly in the articles "Activated Sludge Control and Prevention of Bulking at Rockville Centre" in the issue for September, 1936, and "Inspection and Cleaning of Digestion Tanks at Rockville Centre" in the issue for May, 1938.

The plant, as is well known, is now operating over capacity, and although some have thought in the past that the aeration system would not take care of the rated capacity of 2 M.G.D., the plant has averaged a daily flow of 2.1 M.G.D. for the past three years, with peak loads as high as 3.0 M.G.D. for two weeks at a time during the wet season.

Table 1 summarizes population, house connections and flow. The population figures in 1939 and 1940 were taken by the Rockville Centre Police Department. The population figure used in our 1940 report is based on the 4,669 house connections at four persons per connection, which gives us a total population of 18,676 residents using the public sewer.

The Author

TABLE 1

Year	Population	Connections for Year	Total to Date	Average Flow
1935..	16,500	149	3,933	1.540
1936..	16,627	155	4,083	1.636
1937..	17,200	112	4,200	1.987
1938..	17,600	114	4,306	2.176
1939..	19,300	141	4,480	2.121
1940..	21,500	212	4,669	1.934

The operation has been made possible only by "complete" operation; that is, by running the plant, and not having the plant run us. "Complete" operation requires careful and continued attention. In a biological process the work is done by a variety of "animals," with groups of vegetables, and we like to think of the process as similar to those which maintain balanced aquariums. I might recommend to you the balancing of an aquarium as a most interesting and educational hobby.

If the several varieties of life in the activated sludge process are not properly cared for, they will run wild and show their displeasure by upsetting the plant operation. To obtain satisfactory results one must study the whims and tastes of the organisms which are doing the work. It is not essential that we know the desires of each individual organism. By careful observation, however, we can learn how the group will work to best advantage. After we have determined the best environment for the organisms, it then requires continued and careful tests and checks to see that these conditions are maintained. At Rockville Centre we have found that our "bugs" are happy and contented under the following conditions.

Some Basic Factors and Primary Considerations

In operating the aeration tanks it is essential to effectively control the withdrawal of sludge from the final clarifiers. Only by this procedure can we secure and maintain what we call the required consistency or solids content in the return sludge. This is accomplished by the use of a weir, which permits frequent measurements of the returned sludge so that only the required amount, and no more, is added to the mixed liquor. We thus maintain very close to the optimum amount of sludge. By optimum is meant only that quantity requisite to properly purify the sewage, while also insuring an excess of oxygen to maintain the health of the biological life. We maintain that more than that is not only a waste of effort and power, but invites trouble. Many claim that there should be an abundance (more than is essential) of sludge in the mixed liquor, to give a high polish to the process. At Rockville Centre the activated process is followed by vacuum filters. The effluent from the final clarifiers are freed of remaining suspended solids by its passage through the blanket which is formed from waste paper pulp added to the effluents for the purpose. I feel it good economics to divide the work between the various units of the plant as far as practice and performance will permit. Since the final filters do a portion of the work, we effect a saving by reducing somewhat the purification in the activated sludge portion of the treatment. This is brought about by trimming the air input and sludge return to bare minima. I have found that with this method of operation the aeration tanks, which most would consider overloaded, can be made to give consistently good results with a complete elimination of bulking.

Solids in Sludge Returned

In our operation the sludge returned is kept at about 2.5 per cent

*This paper, read before the New Jersey Sewage Works Ass'n, is here reproduced by permission of the association.

solids, i.e., 25,000 p.p.m. It can be allowed to concentrate to as much as 35,000 p.p.m. in the final clarifiers without trouble, especially in cold weather. Our operation changes somewhat when the temperature drops below 58 degrees Fahrenheit, when we get a slightly different reading on our centrifuge.

We still use our knuckle jointed fan made into a centrifuge operating at 1,800 r.p.m. to determine our sludge concentration. As a check the solids are determined by evaporation and weighing daily. The sludge concentrates very rapidly. In order to maintain the proper amount of sludge in the mixed liquor, excess sludge is withdrawn as required by increasing or decreasing the sludge to waste which is taken off of the return line, which is flowing constantly. Although the process may seem complicated, the flow and solids conditions are practically the same every day and this operation has therefore become a routine. In the final clarifiers the sludge blanket is kept at about 1½ feet in depth. As this is the hopper part of the tank, it amounts to very little in the way of volume or weight of sludge, which is deprived of renewed aeration for any appreciable period of time. This feature we consider of prime importance to good operating economy.

By maintaining the proper amount of sludge in the mixed liquor and keeping the returned sludge from suffering any appreciable reversion, and at proper density, the sludge entering the final clarifiers is of such quality and quantity that it settles very readily in the space and under the conditions to which it is subjected, such as the continuous upward flow of the clarified liquor and the downward movement of the sludge. Sludge that settles readily also concentrates quickly, and under the action of the clarifying equipment, such as scrapers, can become very heavy.

Synchronization of Sludge Handling Equipment

An important factor in the consolidation and return of activated sludge is the rate of output of the sludge return pump in relation to the sludge gathering equipment. A pump operating too fast will cause a short circuit in the bottom of the clarifiers, allowing clear water to enter the pump suction instead of sludge. If the pump is too slow, sludge will accumulate and age too greatly in the clarifier. Also important is the operation of the measuring device determining the amount of sludge to be returned and the available equipment for taking off excess sludge continuously.

Our method of measuring sludge has been changed somewhat from what it was in the last published account of this work. An orifice is now employed instead of the Cippoletti weir. Because of its confining or retarding ability, the orifice is more positive, thereby insuring only the required amount of sludge in the mixed liquor. Incidentally, the use of this type of measuring device showed that the solids in the return sludge could be maintained at 25,000 p.p.m. or 2.5 per cent solids and reduce the return in gallons considerably.

The Centrifuge Test

The use of the centrifuge is necessary in obtaining an immediate determination of the quantity of solids in the sludge and mixed liquor as frequently as desirable. In the test 15 ml. of the sample is employed. The centrifuge tube is graduated in 10ths up to 15 ml. After filling, it is spun for 3 minutes at 1,800 r.p.m. of the centrifuge. The reading on the return sludge that we find giving best results is 14 ml., but, as stated before, in the cold weather the sludge concentrates considerably on its own, and so at that time we reduce the required reading to a range of from 10 to 12 ml. after 3 minutes on the centrifuge, and obtain the same quantity of solids in the sludge as when using the reading of 14 ml. during months of higher sewage temperatures.

Keeping the Oxygen Balance "Out of the Red"

Activated sludge has a very high oxygen demand, and sometimes a very rapid demand, as many have learned. It is, therefore, most important that the sludge have a sufficient supply of oxygen to supply its needs at any period of its history in the aeration tanks. A lack of oxygen will cause trouble due to anaerobic conditions that set up within the sludge. As a check on the available oxygen in the aeration system, the standard Winkler determination for dissolved oxygen is made on samples of the mixed liquor taken from each aeration tank. Our procedure was published in the November, 1936, issue of WATER WORKS AND SEWERAGE in an article entitled "Running an Activated Sludge Plant on D. O. Determinations."

The oxygen determination is a part of the routine operation. The air input to the mixed liquor is regulated to the demand for oxygen and, as many of us know, the demand for oxygen tapers off in the treatment cycle. The surplus maintained ranges from 1 p.p.m. at the start of the treatment to 3 p.p.m. in the last stage before going to the secondary settling tanks. The aeration system consists of six rectangular tanks and they are divided so that three tanks and a secondary settling tank or clarifier make one unit. The mixed liquor flows over a weir to each unit and thereby insures equal flow to each clarifier. By keeping the quantity of sludge in the final clarifiers at a minimum we prevent septic conditions in this part of the cycle where the sludge is temporarily deprived of oxygen supply. Another check which we have and use on the aeration tanks is the settling test.

The Settling Test

In the routine test for settleability and volume of solids, if there is more than 20 per cent sludge by volume in a cylinder after 10 minutes of settling, and this condition continues for 24 hours, we consider that bulking is imminent. The condition is corrected by removing this sludge from the system as rapidly as we can—a case of "house cleaning."

We have not found it necessary in the last six years to use the lime treatment that aided in getting the sludge under control. As a part of the routine operation, the tubular air diffusers are back flushed regularly once every week with city water. The air input is regulated by valves to taper off the air as the sludge sewage mixture travels from inlet to outlet of the aeration units. The dissolved oxygen test aids in this operation materially.

The Importance of Records

Table 2 summarizes our operation of the aeration tanks for the last six years.

TABLE 2

Year	Return Sludge p.p.m.	Mixed Liquor	Air Consumption	% Sludge	Sludge Index Ave.	Sludge Index Max.	Sludge Index Min.
1935.....	11,600	1217	2.4	9	80	171	38
1936.....	11,283	891	1.8	5	92	199	40
1937.....	11,056	733	1.8	5	118	381	30
1938.....	13,000	744	1.8	3	108	250	31
1939.....	16,439	745	1.9	5	68	116	42
1940.....	27,285	785	2.1	5	49	91	30

Records of our operation are kept in detail and monthly reports are sent to the New York State Department of Health. Table 3 gives a brief summary of our results. This table illustrates how the load is divided between the activated sludge units and the final filters. For instance, for 1940 the clarified effluent had 28 p.p.m. suspended solids and 44 p.p.m. B. O. D., while the filtered effluent contained but 13 p.p.m. solids and 26 p.p.m. B. O. D. Our filters not only insure clear effluent but also add to the flexibility of the plant and the ease of mind of the superintendent. One of the filters used for dewatering pulped waste paper aids in dewatering approximately 20 per cent of the total sludge. The waste pulp is used as a filter medium, aided by chlorine in solution, which is fed into the mixing tank during a 2 to 3 hour filter operation.

TABLE 3

Average Daily B.O.D. of Treatment Process

Year	Raw	Primary Settling	Secondary	Filter
1935....	240	184	35	18
1936....	220	166	37	20
1937....	249	154	35	20
1938....	271	162	29	17
1939....	279	164	35	22
1940....	259	161	44	26
Average Suspended Solids				
1935....	282	125	34	5
1936....	214	112	42	11
1937....	319	150	37	13
1938....	422	172	29	11
1939....	478	159	33	16
1940....	340	139	28	13

Sludge Digestion

In the sludge digestion tanks we have another group of bugs that work. These also were studied to find their desires, and the tanks are now operated in accordance with our findings. Briefly, our operations based on these findings are as follows: Fresh solids are added to the digestion tanks daily at the rate of 7.5 per cent fresh solids to ripe sludge, on the basis of organic content. On the average 25,082 cu. ft. of ripe sludge is retained in the digestion tanks daily. It has an average solid content of 4 per cent and a volatile content of 51 per cent. Fresh solids added to the ripe sludge averaged 1,270 cu. ft. daily. These solids (mixture of crude and activated sludges) averaged in solids 3.8 per cent, and in volatile content 85 per cent.

Before they are added to the digestion tanks, the activated and primary sludges are mixed, and after settling, the supernatant liquor is drawn off. The wasted activated sludge is taken from the sludge return line and discharged into plain settling tanks built for that purpose. After settling, the tanks are decanted. The solids content of this sludge averaged 3.2 per cent in 1940. Appended are Tables 4 and 5, which give the sludge data as reported for the year 1940.

The sludge digestion tanks are heated, and temperatures range from 75 to 95 degrees Fahrenheit, with an average of 85 degrees. Once every week the temperature, pH, and sludge depths are obtained. The pH of the sludge is maintained at 7.1-7.3. Sludge is drawn weekly with the exception of January and February, when it is drawn twice monthly. Because of the concentration of the activated sludge, only 9,500 gallons per day is added to the digestion tanks and a corresponding quantity of supernatant liquor is returned to the raw sewage. This reduction of liquid input per pound of solids transferred is a highly important factor toward efficient digester performance and in

TABLE 4

Sludge Data—1940

	Primary Sludge (cu.ft.)	Tests	Percent Solids	Waste Act. Sludge (cu.ft.)	Tests	Percent Solids	Sludge to Filter (cu.ft.)	Tests	Percent Solids
January	21,312	11	2.9	29,568	10	3.0	21,312	4	3.1
February	19,392	7	3.5	30,720	6	3.1	5,568	6	3.2
March	20,928	8	4.3	30,336	8	3.2	9,024	8	2.5
April	20,928	9	5.0	26,304	10	3.2	14,400	12	3.1
May	23,424	9	3.6	25,152	8	4.2	16,704	8	3.4
June	22,848	8	3.8	26,304	8	3.5	14,208	10	3.5
July	23,232	9	3.9	28,032	9	3.2	14,784	7	3.0
August	22,256	7	4.5	29,568	7	3.1	11,904	8	2.8
September	20,736	9	3.3	28,992	9	2.8	11,520	7	2.6
October	23,808	9	3.4	32,400	8	4.0	14,976	10	4.0
November	23,040	7	3.9	30,408	7	2.7	16,704	9	2.7
December	23,808	8	3.8	29,568	8	2.8	17,664	6	2.6
Total	265,712	101	45.9	347,352	98	38.8	168,768	95	36.5
Monthly Average	22,148	8	3.8	28,946	8	3.2	13,064	8	3.0

	Combined Sludge to Digesters (cu.ft.)	Tests	Percent Solids	Digested Sludge to Beds (cu.ft.)	Tests	Percent Solids	Air Dried Sludge Cake (cu.ft.)	Tests	Percent Solids
January	47,040	25	3.5	9,600	5	3.1	2,943	7	13.7
February	44,544	22	3.5	6,400	4	3.2	2,484	5	15.8
March	43,008	26	4.0	6,400	1	3.4	479	1	15.0
April	32,256	23	4.2	10,240	4	3.4	1,704	7	27.0
May	31,014	21	3.8	10,240	4	4.8	1,890	3	21.0
June	33,600	24	4.1	10,240	4	5.3	1,998	3	67.9
July	37,248	26	3.8	12,800	5	3.7	2,106	5	41.6
August	40,836	24	3.7	10,240	4	6.2	2,430	5	47.0
September	40,320	24	2.8	10,240	4	6.2	1,782	4	38.8
October	41,664	26	4.0	8,960	4	6.1	1,944	4	33.6
November	35,904	19	3.9	1,280	1	7.8	1,593	1	32.0
December	35,904	16	4.0	2,240	4	4.6	1,134	2	21.2
Total	463,338	276	45.3	98,880	44	57.8	22,487	47	374.6
Monthly Average	38,611	23	3.8	8,240	4	4.8	1,870	4	31.2

TABLE 5

Sludge Solids and Gas Yields—1940

Sludge	% Solids*
Primary Sludge	3.8
Waste Activated	3.2
Combined Sludge to Digestion Tanks	3.8
Sludge to Filter	3.0
Digested Sludge	4.8
Range	3.1–7.8
Air Dried Sludge	31.2
Range	13.7–67.9

*Averages.

Average Lbs. Raw Solids/M.G. Treated Annually

Primary Sludge	893
Waste Activated Sludge	984
Solids recovered from plant effluent by vacuum filtration	125
Total	2,002
Lbs./M.G. Treated by Digestion Tanks	1,469
Lbs./M.G. Dewatered by Mechanical Filter	447
Lbs./M.G. Recovered by Clarifying Filters	125
Total	2,041
Average Lbs./M.G. Air Dried Sludge	600
Average Lbs./Capita Raw Solids Daily	.207

the supernatant liquor problem. As a result of our careful operation of the digestion tanks the supernatant liquor is of good quality, with a B. O. D. average of only 200 p.p.m., and be cause of the resulting small quantity of returned supernatant liquor of excellent quality there is no further deleterious effect on the aeration tanks in this method of disposing of supernatant.

TABLE 6

Gas Collection—1940

	Average	Maximum	Minimum	Total
January	19,264	24,000	15,800	597,200
February	23,960	26,500	17,300	591,500
March	21,117	28,000	10,100	654,620
April	18,370	20,200	12,000	554,100
May	19,084	24,000	15,100	591,600
June	20,660	29,000	17,000	619,800
July	19,632	27,500	16,000	608,600
August	18,071	21,000	13,800	560,200
September	18,629	12,000	15,400	541,700
October	18,674	22,800	12,300	578,900
November	18,600	22,500	15,000	558,000
December	18,077	20,600	14,300	560,400
Total	234,138	278,100	174,100	7,016,620
Monthly Average	19,511	23,175	14,508	584,718

1941—Municipal Year Book

Clarence E. Ridley and Orin F. Nolting, editors. International City Managers' Association, 1313 East 60th Street, Chicago. 662 pp. $5.00, postpaid.

The final 1940 census figures are an important feature of this eighth edition of the standard reference work on activities and statistical data for American cities. The 2,042 cities over 5,000 population include 234 cities which moved above 5,000 population during the last decade. All comparative data have been revised to correspond to the classifications adopted by the Census Bureau.

New sections in this Year Book include data on retirement plans, credit unions, electric plants, airports, health departments, and sewer rentals. Much new information is contained in the sections on annual reports, police, fire, housing, traffic safety, and parking meters.

The Year Book also contains the usual up-to-the-minute accounts of developments in the various fields of municipal activity, an up-to-date list of selected model municipal ordinances, a standard list of references in each field of municipal activity, a list of sources of municipal statistics, publications issued in 1940, detailed lists of services available from federal and national agencies, and many other special sections which make the Year Book an exceedingly valuable aid to mayors, city managers, department heads, librarians, and others interested in local government administration.

The 1941 Year Book continues the plan of placing in a single section all information pertaining to a particular function or activity. A detailed index includes reference to material appearing in the seven preceding issues of the Year Book but not repeated in the 1941 edition. This feature, together with a thumb-tab index, increases the usefulness of the book.

An appendix lists names and positions of the 13 principal municipal officials in every city of more than 25,000 population. And for every city of more than 5,000 the name of the Mayor and City Clerk.

Concrete Pipe Used Throughout in New Sewer System

The new sewer system for Coeur d'Alene, Idaho, being installed as a W.P.A. project, is now about 50% complete. Although the system will cost $200,946, the sponsor is contributing something less than 25%—namely, $47,000 only.

A feature of interest in connection with this project is the use of concrete pipe throughout, from the 30 inch trunk sewer through to the smallest laterals. The footage of pipe involved is made up of the following sizes:

30″ Trunk Sewer .. 4,900 ft.
24″ Trunk Sewer .. 4,600 ft.
8″ Laterals .....21,000 ft.
6″ Laterals ..... 7,800 ft.

Another feature of interest is that better than 1,000 ft. of the sewer entails tunnelling, much of which is through solid rock 50 ft. below surface.

"Bob" Haywood Back in Operating Game

R. W. ("Bob") Haywood, Jr., has recently resigned from his position with Industrial Chemical Sales in order to accept appointment as Sup't of Filtration at Chester, Pa. He fills the position vacated by Rennie I. Dodd, who was made General Superintendent of the system by the Chester Water Authority.

"Bob," prior to his connection of several years with "Nuchar" sales, was Sup't of Filtration at Easton, Pa., and prior to that at Gastonia, N. C.

E. E. Wall Resigns—Succeeded by Max H. Doyne

Mr. Edward E. Wall, for many years Director of Public Utlities at St. Louis, Mo., has tendered his resignation. He is being succeeded by Max H. Doyne, consulting engineer of St. Louis.

Mr. Wall in wishing to retire at the age of 80, after having served the city of St. Louis for almost 50 years, did so under an agreement with Mayor Becker to the effect that nearly 100 employees of the Water Department, with service records of 15 years and longer, would not lose their jobs under the new administration.

Mr. Wall, a native of New York City, and graduate of Cornell University, was first employed in the St. Louis Water Dept. in 1888. He left to take up private consulting practice but returned in 1892 as assistant engineer in charge of water treatment. In 1911 he became Water Commissioner and in 1925 Director of Public Utilities. That same year he was fired by the Mayor for insubordination, in refusing to dismiss two employees. He was reappointed at the next change in administration in 1933.

The "deal" made between Mr. Wall and the new Mayor, concerning his resignation provided the 100-odd old employees be not dismissed, constituted something unique in the annals of politics and water supply. It is believed that Mr. Wall's standing in the city and his long term of satisfactory public service was the trump card which prevented his dismissal and permitted him to "resign" under the agreement protecting his old employees.

Mr. Doyne, who succeeds Mr. Wall, is head of the firm of C. E. Smith & Co., St. Louis consulting engineers, specializing in public utility rate cases.

THE WATER POLLUTION ABATEMENT PROBLEMS OF THE PETROLEUM INDUSTRY*

By R. F. WESTON[1]
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THE ATLANTIC REFINING CO.
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**The second of a series of articles dealing with the oil field and refinery waste problem and measures taken in pollution abatement by the petroleum industry. The initial article appeared in "Water Works and Sewerage" for January, 1941.*

R. F. Weston

W. B. Hart

THE Petroleum Industry of the United States, as it is known today, had its beginning near Titusville, Pa., in 1859 when Col. Drake produced crude oil from the first drilled well. A market for burning oil already existed, and the completion of the Drake Well was immediately followed by intense drilling activity and the construction of many small refineries adapted to the distillation of the crude oil production.

From the completion of this first oil well until about 1885, burning oil (kerosene) was the principal and practically the only marketable petroleum product. In the following years, 1885 to 1904, mineral lubricating oils gained favor to give impetus to the expansion of the growing industry. During this period the increased demand for petroleum products and the poor transportation facilities available stimulated exploration activities in many localities. New fields were discovered in the Appalachian and the Lima-Indiana regions, in the Midcontinent area, in the Rocky Mountain district, in California and in Texas.

From 1904 to 1919 the industry experienced a most important period of growth as the result of the advent and development of the internal combustion engine and the automobile. This development changed the status of gasoline from that of a waste material to that of the principal source of revenue. The expansion of the automotive and aircraft industries, the increased use of oil for heating and producing power, the development of many new petroleum products and the advances in petroleum engineering and technology all have contributed to the growth of this industry to its present status.

(1.) Sanitary Engineer, The Waste Control Laboratory.
(2.) Engineer in Charge, Waste Control Activities.

A Fourteen Billion Dollar Industry

Today the Petroleum Industry represents a capital investment of thirteen to fourteen billions of dollars. The industry provides employment for about one million individuals.[1] It either directly or indirectly provides an annual tax revenue to the government in the amount of about one billion, three hundred million dollars.[1] As the nation's fourth largest industry, its products, numbering in the hundreds, have an annual value of about two billion five hundred million dollars.[1] The major product classes and their quantities are shown in Table 1.

In the United States there are about 390,000 active wells which produced approximately one and one-third billion barrels of crude oil in 1940.[2] These wells are located in many fields and districts in over 20 different States. The fields and districts of major importance are shown in Fig. 1.

The crude oil produced is processed in 461 operating refineries (Jan. 1, 1940) having an aggregate capacity for charging about 4,200,000 barrels of crude oil per day.[3] These refineries are distributed in 36 states with notable concentrations in Texas, California, Louisiana, Oklahoma, Pennsylvania, Illinois, New Jersey and Kansas. The distribution of refining activity is shown in Fig. 2.

The crude oil and the finished products are transported over land by pipe lines, railroad tank cars and tank trucks, and over water by tankers and barges.

The marketing of petroleum products, through over four hundred thousand gasoline retail outlets[1] and many other retail establishments, is a major activity of the largest city and the smallest village.

In consideration of the magnitude, diversity and distribution of the Petroleum Industry and the great number and variety of its products, it is apparent that the production of many waste materials is inevitable. The more important wastes of the industry are shown in Figs. 3, 4 and 5. The problem of properly disposing of these wastes, to prevent water pollution, depends on the operation involved, the magnitude, location and individual processes of this operation and the quantity, characteristics and uses of the receiving waters. Therefore, it must not be concluded that all of the wastes designated will cause objectionable water pollution. On the contrary, some originate at points from which they cannot obtain access to natural waters and others are very small in quantity or are of a character that will not cause objectionable pollution conditions. There are still other wastes that are processed for constituent recovery or destroyed by burning or other procedures. However, certain major types of wastes may and do cause water pollution problems.

It is the purpose of this discussion to briefly describe the source and characteristics of these wastes and to set forth the problems confronting the Petroleum Industry in providing for their proper treatment or disposal. In discussing these problems of water pollution abatement they will be classified, as shown in Figs. 3, 4 and 5, according to the three major groupings of the industry's activities, i.e., (1) production, (2) refining, and (3) marketing. For convenience, the transportation of crude oil from the well to the refinery has been included in production and the transportation of the finished product from the refinery to the consumer has been included in "Marketing." In order to more clearly set forth the various types of processing or operations of the three divisions, diagrams are shown in Figs. 3, 4 and 5. It should be clearly understood that these figures are not flow diagrams of any specific field,

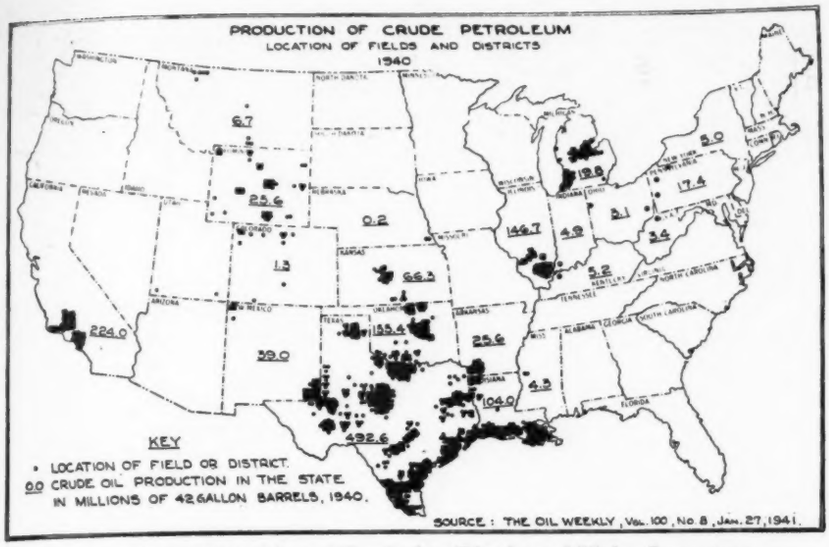

Fig. 1.—U. S. Oil Fields and Producing Districts of Major Importance.

plant or operation, for with few exceptions there is wide variation in procedure although similar products are produced, processed or handled.

TABLE 1—U. S. PRODUCTION OF REFINED PETROLEUM PRODUCTS 1939[1]

Product	Barrels	Per Cent of Total Crude Charged to Stills
Gasoline	595,925,000	44.9
Kerosene	68,521,000	5.5
Gas oil and distillate fuel oil	161,670,000	13.1
Residual fuel oils	306,896,000	24.8
Lubricants	35,036,000[4]	2.8
Wax	1,659,000[4]	0.1
Coke	8,332,000[4]	0.7
Asphalt	27,248,000	2.2
Still gas	66,979,000[4]	5.4
Road oil	7,868,000	0.6
Other finished products[2]	2,359,000	0.2
Shortage	7,345,000	0.6
Unfinished crude gasoline and oils (net)[3]	11,511,000	0.9

Authority—Minerals Year Book, 1940, U. S. Department of Interior, Bureau of Mines.
1. Preliminary data.
2. Other finished products may include such materials as petroleum ether, alcohols, acetates, lacquers, soaps, glycols, varnishes, synthetic rubber, commercial solvents, cleaning fluid, anti-freeze, insecticides, dielectric oils, floatation oils, technical and medicinal oils, cosmetic bases, sulpho acids, wood preservatives and many others.
3. A negative quantity; represents net excess of unfinished oils rerun over unfinished oils produced.
4. Equivalent barrels of crude charged.

Petroleum Production

The wastes of Petroleum Production, Fig. 3, may be classified, in a general way, as those incident to drilling the well and those incident to operating the well.

Oil may be a waste from both of these procedures. Its occurrence comes about as a result of blowouts during drilling, the operation of completing the well, the leakage of lines, valves, pumps, tanks, etc., the drawoff from separators and tanks and accidental spills. Because oil is a valuable material, its loss is accidental, rather than intentional. When, as a result of accident, oil does escape, it may cause the pollution of surface waters by surface drainage or the pollution of ground waters by seepage. Since waste oil is more general to refining, the effects of oil on the receiving waters and their uses will be discussed under Petroleum Refining. Oil pollution from Petroleum Production has been minimized in recent years by the installation of equipment designed to intercept leaks and spills and by the general use of good housekeeping methods. The larger and better regulated fields are remarkably free of oil leaks and spills because of careful operation.

The oil pollution of harbors by oil-transporting vessels may be caused by leaks, spills, overflows, oil contaminated cooling water and ballast or bilge water.[29] Pollution from this source has been greatly reduced by the installation of ballast and bilge water tanks, properly constructed impervious docks and leak and spill intercepting equipment.

Drilling Mud

During recent years there has been a marked increase in the use of specially prepared drilling "muds." Drilling "mud" or "fluid" is used to seal sub-surface pressures, to lubricate and cool the drill and to remove drill cuttings without interfering with the drilling operation.[28] Sometimes the mud or cuttings produced in the drilling operation is satisfactory, but frequently a special mud must be "imported" and prepared to meet the required conditions of density, viscosity, fluidity, surface tension, water retention, etc. Many different chemicals may be used in the preparation of a mud of the desired characteristics. Some of these chemicals are barytes (barium sulphate), amorphous silica, iron oxide, strontium sulphate, several of the complex phosphates and sodium silicate. Caustic soda, soda ash, tannin in the form of quebracho or other bark extract, gallic acid, humic acid, etc., are often used together. The constituents of any drilling mud are dependent on the source of clay and the drilling conditions encountered, so no general description as to constitution or character can be devised.

In general, drilling muds are carefully conserved because of the high cost of their preparation. Where difficult drilling conditions are encountered, the cost of the drilling of mud alone may be $40,000 to $50,000. Consequently, little is allowed to escape. Although drilling mud could create serious pollution problems, by its oil content, by creating high turbidity, by changing the mineral and physical-chemical characteristics of the waters, and by increasing the organic matter load on natural purification agencies, such problems are rare.

Salt Water

Few oil wells are drilled and little crude oil is produced without the occurrence of greater or lesser quantities of water. This water is generally more or less saline, so that in some fields its disposal is the major problem of oil production.

The quantities of salt water produced and the characteristics of these waters are dependent on the geological conditions encountered. Obviously, there is great variation from field to field and there is variation from horizon to horizon in the same field. Information available concerning fields that have a brine disposal problem indicate that brine production may vary from 15 bbls. or less to over 4,000 bbls. per well per day.[4,5] The quantity of brine produced ranges from about 4 to about 96 per cent of the total volume of oil and water produced by the well.[5,6] In general, the water production increases with the age of the field.

A few typical analyses of oil field brines are shown in Table II. A study of these analyses from fields where brine disposal is a problem, indicates the undesirability of disposing of proportionately large quantities of these wastes into natural waters. Uncontrolled discharge of oil field brines into surface waters could make these waters unfit for domestic

supply,[6,7,8,9,10,11] livestock consumption[12,13,14,15,16] and industrial[17,18] use, also unfit for sustaining fish life[19] or other normal aquatic animals or plants and unfit for irrigation.[20,21] In a few cases, fresh ground water strata used as a source of domestic water supply have been seriously polluted by oil field brines.[8,9,22]

Relatively small quantities of waste water may be obtained from demulsification and desalting processes.[26,27] In general, these wastes will have the same characteristics as the oil field brines, although in some cases water soluble chemicals used in treating the emulsions also will be present.

It is apparent from an inspection of the analyses shown in Table II that oil field brines contain many marketable substances. If these substances were extracted from even a small percentage of all the produced brines, the markets would soon become flooded and profit from recovery would disappear. Today, oil field brine disposal is an outstanding case in refutation of the somewhat prevalent idea that all industrial wastes can be treated for disposal at a profit.[23,24,25]

Present methods of brine disposal such as controlled water production, return to subsurface formations and controlled discharge to surface waters and, in some cases, natural evaporation in ponds or evaporation for constituent recovery, have greatly reduced brine pollution. However, brine disposal still is one of the major pollution abatement problems of the Petroleum Industry.

Petroleum Refining

An examination of the schematic drawing, Fig. 4, showing refining operations[28,46] and their wastes, reveals that certain wastes are general to all operations and that others are specific to individual processes. One of the first problems that confronts the refiner is that of determining which wastes may be allowed to flow to the general plant drainage system and which must be segregated and corrected at the point of origin. This problem exists because there are some wastes that are small in quantity but great in polluting characteristics that could make it necessary to correct the entire plant discharge. There are also some wastes that would require treatment that would be inconsistent with the treatment required by another. Consequently, in the interests of economy and waste water quality, it is necessary to segregate certain waste materials and treat these materials at their source.

TABLE II—TYPICAL ANALYSES OF OIL FIELD BRINES

Field — Producing Formation	Specific Gravity at 15.6° C.	Total Solids, ppm	Calcium (Ca), ppm	Magnesium (MG), ppm	Sodium and Potassium (Na & K), ppm	Iron, ppm	Bicarbonate (HCO_3), ppm	Sulphate (SO_4), ppm	Chloride (Cl), ppm	Bromide (Br), ppm	Iodide, ppm	Total Hardness	Alkalinity, ppm	pH	Reducing Compounds as H_2S, ppm
ILLINOIS—															
Bartelso[1]—Carlyle	1.032	43,630	861	482	15,424	11	196	8	26,590	52	6	.....	126	7.1	2.0
Centralia[1]—Weiler	1.071	98,171	3,330	1,457	32,667	28	106	7	60,440	132	4	.....	102	7.2	3.0
Louden[1]—Stray	1.080	113,150	3,680	1,363	38,306	33	194	129	69,379	64	2	.....	134	7.7	3.7
Salem[1]—Benoist	1.085	120,858	4,240	1,575	40,381	58	128	90	74,263	120	3	.....	47	7.2	3.4
North Aden[1]—McClosky	1.093	131,090	4,769	2,992	41,592	..	143	948	80,450	188	8	.....	159	7.7	79.0
Sandoval—Devonian	1.063	87,140	3,860	1,335	27,927	..	301	44	53,530	140	3	.....	273	7.0	65
KANSAS—															
Welch[2]—Chat	....	163,050	7,832	1,985	44,610	..	20	27	88,230	383	..	27,700	...	..	107-182*
Silica[2]—Siliceous Limestone	....	23,890	1,018	374	6,840	..	666	1,292	12,100	27	..	4,077	...	..	..
Breford[2]—Kansas City	....	168,950	8,980	3,750	40,070	..	104	56	88,300	458	..	37,817	...	..	..
Cunningham[2]—Lancing	....	251,200	13,188	8,960	57,340	..	39	51	137,500	688	..	69,729	...	..	..
Ritz-Canton[3]—Viola Lime	1.031	52,640	4,420	2,230	9,325	..	156	10	28,600	...	..	20,193	...	..	..
OKLAHOMA—															
Sample 1[4]	1.162	235,982	10,753	2,691	76,915	..	31	348	145,244	...	..	.....	...	..	..
Sample 2[4]	1.081	115,609	5,530	1,625	36,914	..	177	2	71,361	...	..	.....	...	..	..
Sample 3[4]	1.076	107,235	4,708	1,939	34,058	..	...	44	66,486	...	..	.....	...	..	..
Sample 4[4]	1.162	238,045	12,822	2,748	75,400	..	92	184	146,804	...	..	.....	...	..	..
Sample 5[4]	1.026	36,167	1,254	396	12,229	..	119	8	22,161	...	..	.....	...	..	..
TEXAS—															
Upton County[4]	1.007	8,522	822	278	1,641	..	677	2,675	2,429	...	..	.....	...	..	..
Kilgore[5]	....	67,649	1,388	282	24,540	..	569	278	40,598	...	..	.....	...	..	..
Longview[5]	....	68,964	1,432	335	24,653	..	387	259	40,598	...	..	.....	...	..	..
Upshur[5]	....	69,592	1,452	350	25,185	..	250	110	42,245	...	..	.....	...	..	..

*H_2S Concentration from 3 fields in siliceous formation are in this range.
Note: Barium, Selenium, rare metals and other elements not noted above may exist in brines.
Source of Information:
1. Study of Brine-Disposal Systems in Illinois Oil Fields, Sam. S. Taylor, W. C. Holliman and C. J. Wilhelm, U. S. Bureau of Mines, Report of Investigations, R. I. 3534, August 1940.
2. Disposal of Oil-Field Brines in the Arkansas River Drainage Area in Western Kansas, C. J. Wilhelm, H. M. Thorne and M. F. Pryor, U. S. Bureau of Mines, Report of Investigations, R. I. 3318. October 1936.
3. Preliminary Report on the Disposal of Oil-Field Brines in the Ritz-Canton Oil Field, McPherson County, Kansas, C. J. Wilhelm and Ludwig Schmidt, U. S. Bureau of Mines, Report of Investigations, R. I. 3297. December 1935.
4. The Disposal of Oil Field Brines, Ludwig Schmidt and John M. Devine, U. S. Bureau of Mines, Report of Investigations, Serial 2945, June 1929.
5. Water Analysis of East Texas, The Oil and Gas Journal, p. 57, December 1, 1938.

General

The most general waste material is oil. Because of leaks, separator, storage, and treatment tank drawoff and accidental spills, oil may escape from its normal path to a finished product at many points in the refinery.[30] This oil is valuable, so the refiner guards against all major losses. However, because of the many possibilities for oil to escape, the refiner must provide a comprehensive drainage system that serves all parts of the plant and that terminates in an effective separator or separators.[31] These separators serve as a safeguard against the loss of valuable oil and also as a safeguard against oil pollution.

The term "oil pollution" has been used and discussed on many occasions. Federal laws[32] have been enacted for the abatement of oil pollution, because of the detrimental effect of oil on waters and water uses. Although many of the statements concerning oil pollution have been inadequate, misleading or in error, because of the lack of proper definition of the extent and circumstances of the pollution condition, the undesirability of extensive oil pollution has been well established. The effects of oil pollution are dependent on the quantity and characteristics of the involved oil. Oil on the waters spreads rapidly over wide areas. "It has been determined experimentally that oil placed on a clean water surface of ample size will spread to a thickness of one molecule. If the surface tension of the water has been lowered through the presence of other contaminating substances, this ultimate result may not always be reached.

"Extremely thin films are responsible for the bright bands of color so often observed on the surface of water which has received small quantities of oil. The relation between the thickness of these films, their appearance, and the quantity of oil required to produce them is as shown in Table III.

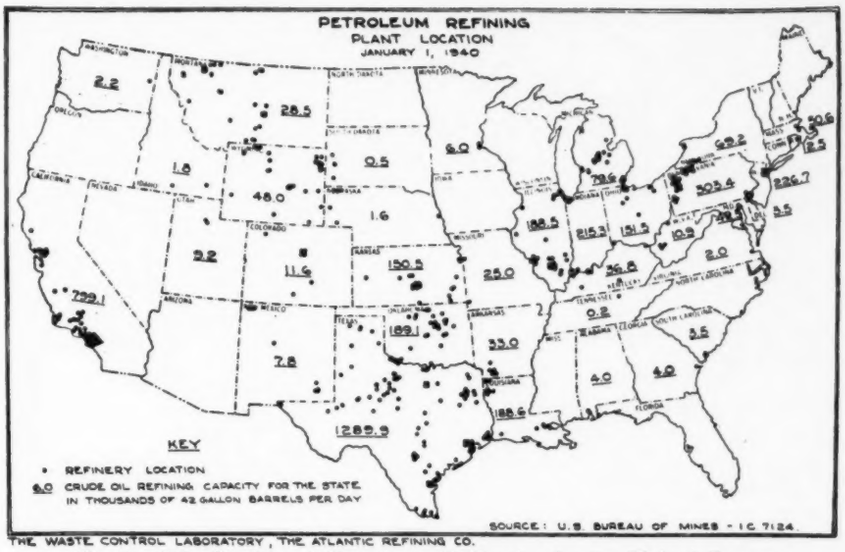

Fig. 2.—Distribution of Petroleum Refineries in the United States.

"Experiments have been made to determine what happens to these very thin oil films when exposed to sunlight and air. Work in the laboratory indicated that films up to 0.000003 in. in thickness did not persist on the average for more than five hours on an agitated water surface.

"These experiments were later substantiated by large-scale tests conducted at sea when large quantities of oil mixed with sea water were pumped overboard and observed over relatively long periods of time. During these experiments the oil required from 40 to 100 hours to film out to an average thickness of the order of 0.00004 in., but once it had reached this thickness, it required less than 24 hours for the oil to disappear from the surface of the sea."[30] Light oils, such as gasolines, will quickly evaporate, while heavy asphaltic oils may form emulsions and persist for a prolonged period of time.[33]

Large quantities of oil that cover large areas or a series of small areas with an oil film create serious pollution problems. Winds or currents may wash oil onto bathing beaches,[34] thus making them unfit for recreational use. Other recreational activities such as boating, fishing and hunting are discouraged by oil pollution.[35] It may destroy aquatic life which it contacts by saturating or forming a coating on parts of the organism, thereby interfering with normal life functions. This may happen to aquatic birds, fish, plants, plankton and other aquatic forms.[36,37,38,39,40,41] Oil on the surface of water may undergo change in character or gather dust and sink to the bottom as a blanketing sludge.[40,41] In this manner the effects of oil may actually extend to deep water and bottom life forms. The presence of oil may impart an oily taste to fish or other edible aquatic life[35] and may interfere with the propagation and growth of clams, oysters and other sea food.[40] Oil on the surface of water can retard re-aeration of natural waters, thereby promoting the depletion of oxygen necessary to sustain aquatic life or the normal oxidation of sewage or other wastes. This effect requires films of considerable thickness over large areas. Floating oil on harbor waters can create a serious fire hazard to ships and docks and can stain the paint on the hulls of vessels.[29] Available evidence indicates that some crude oils contain water soluble constituents that are toxic to aquatic life.[38]

The effects of oil noted above are those due to gross pollution. It is questionable whether minute quantities that may escape from a modern type well-designed separator will cause serious pollution. Oil dispersed through a body of water to the extent of a few parts per million will have practically none of the detrimental effects described above. The reactions of fishes and aquatic plants

TABLE III*—OIL FILMS ON WATER SURFACES

Approximate Trickness of Film (Inches)	Appearance	Approximate Quantity of Oil for Film One Square Mile in Area (Gals.)
0.0000015	Barely visible under most favorable light conditions	25
0.0000030	Visible as silvery sheen on surface of water	50
0.0000060	First trace of color may be observed	100
0.0000120	Bright bands of color are visible	200
0.0000400	Colors begin to turn dull	666
0.0000800	Colors are much darker	1,332

*From "Disposal of Refinery Wastes, Section 1, Waste Water Containing Oil, 2nd Ed., 1933, American Petroleum Institute, New York."

to separated refinery wastes have been observed for periods of several days. The results of experiments with bass, sunfish and sucker fingerlings indicate that the effluents of properly designed separators have no effect on these fish.[42] The effects of other wastes from refineries on aquatic life will be discussed later.

The problem of pollution prevention presented by emulsified oil is much more difficult than that presented by free oil. Unfortunately, emulsions also originate (see Fig. 4) in many different operations and consequently at widely scattered points. Many of these emulsions remain stable until greatly diluted. Emulsions of this type are not removed from the waste water by the plant separators. Later, however, when diluted by the receiving waters, they break and cause normal oil pollution. There are other emulsions, of course, that break when diluted by other plant wastes and the oil is retained by the plant separators. Consequently, it is necessary to study each emulsion to determine its effect on the quality of the plant separator effluent.

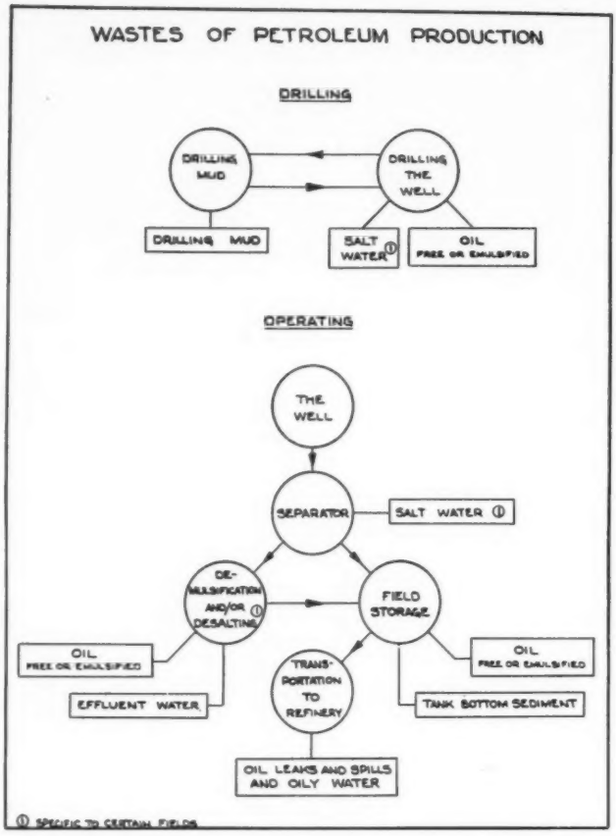

Fig. 3.—Wastes to Be Dealt with from Oil Production Operations.

Some of the stable emulsions carry large quantities of oil and others carry comparatively little oil. Both must be treated, nevertheless, to "break out" the oil and to keep it and its emulsifying agent away from the general plant sewers. In these cases the cost of waste correction far exceeds the value of product return.

The emulsions encountered may be of the type known as water in oil, oil in water, or combinations of both. They vary widely in their characteristics and in the treatment necessary to resolve them into their oil and water constituents. The problems of treatment are further complicated by the fact that emulsions from the same process are influenced in characteristics by variations in the nature of the processed raw material. Another problem associated with the correction of emulsions for disposal occurs because of the nature of the chemical constituents of the water phase. Processes which will effectively resolve most of the emulsions encountered have been devised and are in use.[43] The abatement of pollution from this source has been advanced materially. However, a particularly discouraging problem does arise at times when emulsions are formed in the plant sewers. Occasionally, emulsions of this kind increase the oil content of the plant separator effluents.

Tank bottom sludges, which are generally thick, black accumulations of precipitated complex hydrocarbons, insoluble salts and sediment, are removed intermittently. When tanks are cleaned and this material is removed, it is generally destroyed by burning. These sludges, at times, may be flushed to the sewers. This is not always desirable because the sludge settles out in the sewerage system or in the separators and may interfere with functioning. Its disposal is a definite problem at small refineries where burning space is not available.

Cooling waters and condensing waters are about the only other forms of waste that are general to nearly all operations of the refinery. In some sections of the country water is carefully conserved, treated, cooled in towers or ponds and reused. The waste water flow from these refineries is, in consequence, very low. In other sections where water is plentiful it is usually pumped through the refinery water supply system once, used and then drained to the nearest water course. The problems of waste water correction may be more serious at the plant conserving water, however, because there is probably very little water outside the plant that is available for dilution. In the case of the plant using the once-through system, it is probable that only 10 to 15 per cent of the water ever contacts oil or other wastes and that the adequate dilution available reduces the seriousness of the pollution problem. The temperatures of the waters generally range from about 70° to about 120° Fahrenheit.

Usually, cooling and condenser water is subject only to oil contamination from leaks in tubular equipment, etc. It is a refinery problem, however, to provide separator equipment of some type to guard against the infrequent escape of oil from these sources. The problems of handling large volumes of water are about the only serious ones associated with the disposal of oil free cooling and condensing waters.

Cracking, Polymerization, Alkylation and Related Processes

Cracking, polymerization, alkylation and related processes[28,46] produce general wastes as mentioned above, and also special wastes that are specific to this class of operation. Of these wastes, two may at times present serious pollution problems. These are the scrubbing solutions used for the removal of hydrogen sulphide from gases and the condensate water from distillate separators.

Waste solutions from still gas scrubbing operations may be small in quantity and discharged infrequently when the scrubbing is carried out in a closed system and the hydrogen sulphide is recovered for further processing or burning. In these cases the scrubbing solution, which may contain sodium carbonate, sodium phenalate, sodium thioarsenate, tripotassium phosphate, mono or diethylanolamine or others, are generally regenerated and used for prolonged periods of time.[28,46] When the solutions are replaced they may be collected and then discharged at such a slow rate that dilution will make it impossible to detect the waste by analysis. When the quantity of the waste is great and continuous disposal is necessary, these wastes must be treated at their source. The treatment is expensive and there are

no valuable by-products to help pay its way.

The condensate water from distillate separators may contain solutes that are highly toxic to some aquatic plants and animals. These wastes may contain one or more of such compounds as organic and inorganic sulphides, normal or acid sulphites and sulphates, sulphonic acids and their salts, mercaptans, amines, amides, quinolines and pyridines, naphthenic acids, phenols, etc.[43] They may also contain chemicals used for corrosion prevention such as ammonia, caustic soda, calcium hydroxide, etc.[43] Not all of these substances will be found in a waste water at the same time.

Waste of this type may also contain suspended matter such as coke,

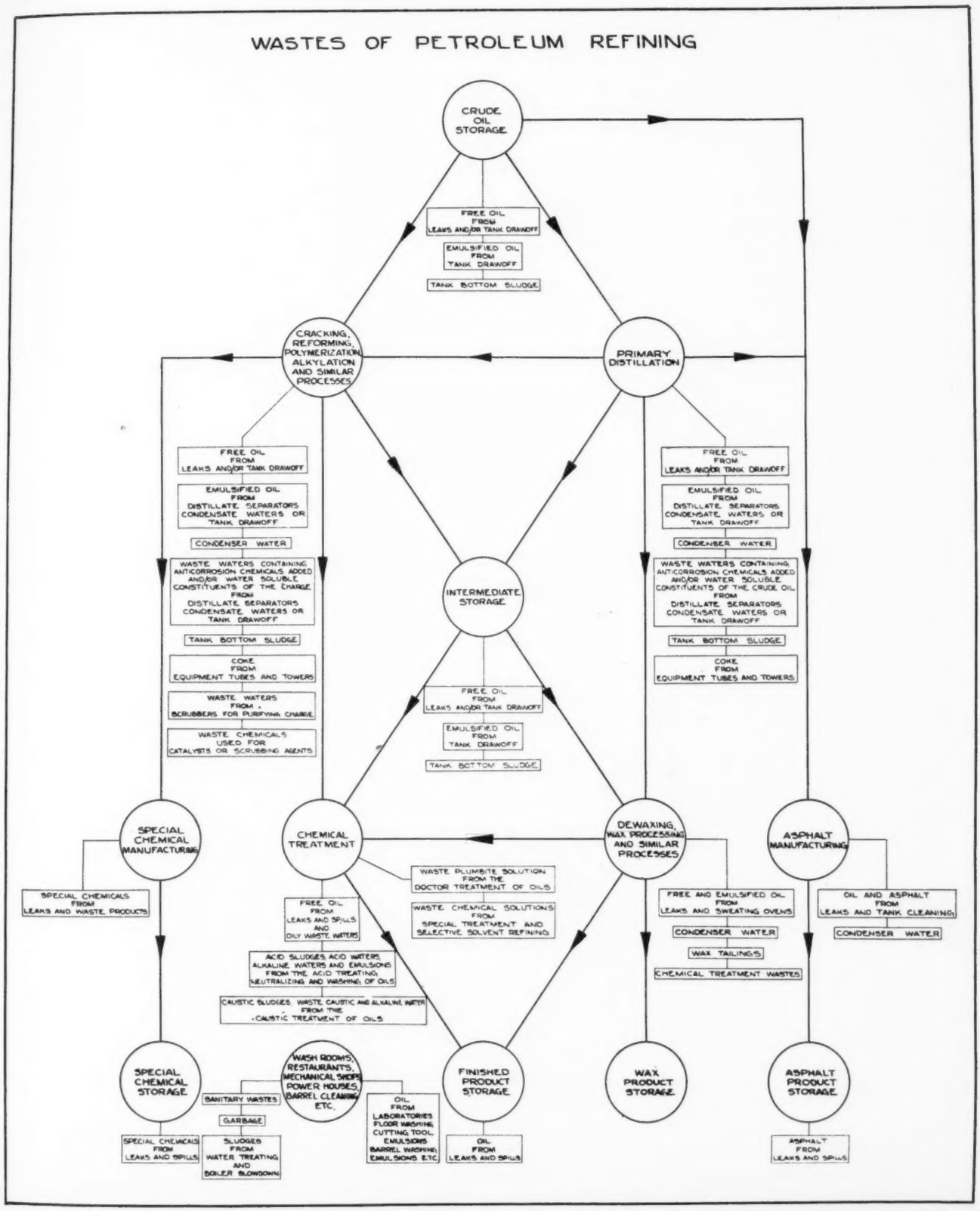
WASTES OF PETROLEUM REFINING
CRUDE OIL STORAGE
FREE OIL FROM LEAKS AND/OR TANK DRAWOFF
EMULSIFIED OIL FROM TANK DRAWOFF
TANK BOTTOM SLUDGE
CRACKING, REFORMING, POLYMERIZATION, ALKYLATION AND SIMILAR PROCESSES
PRIMARY DISTILLATION
FREE OIL FROM LEAKS AND/OR TANK DRAWOFF
EMULSIFIED OIL FROM DISTILLATE SEPARATORS CONDENSATE WATERS OR TANK DRAWOFF
CONDENSER WATER
WASTE WATERS CONTAINING ANTICORROSION CHEMICALS ADDED AND/OR WATER SOLUBLE CONSTITUENTS OF THE CHARGE FROM DISTILLATE SEPARATORS CONDENSATE WATERS OR TANK DRAWOFF
TANK BOTTOM SLUDGE
COKE FROM EQUIPMENT TUBES AND TOWERS
WASTE WATERS FROM SCRUBBERS FOR PURIFYING CHARGE
WASTE CHEMICALS USED FOR CATALYSTS OR SCRUBBING AGENTS
FREE OIL FROM LEAKS AND/OR TANK DRAWOFF
EMULSIFIED OIL FROM DISTILLATE SEPARATORS CONDENSATE WATERS OR TANK DRAWOFF
CONDENSER WATER
WASTE WATERS CONTAINING ANTICORROSION CHEMICALS ADDED AND/OR WATER SOLUBLE CONSTITUENTS OF THE CRUDE OIL FROM DISTILLATE SEPARATORS CONDENSATE WATERS OR TANK DRAWOFF
TANK BOTTOM SLUDGE
COKE FROM EQUIPMENT TUBES AND TOWERS
INTERMEDIATE STORAGE
FREE OIL FROM LEAKS AND/OR TANK DRAWOFF
EMULSIFIED OIL FROM TANK DRAWOFF
TANK BOTTOM SLUDGE
SPECIAL CHEMICAL MANUFACTURING
CHEMICAL TREATMENT
DEWAXING, WAX PROCESSING AND SIMILAR PROCESSES
ASPHALT MANUFACTURING
SPECIAL CHEMICALS FROM LEAKS AND WASTE PRODUCTS
WASTE PLUMBITE SOLUTION FROM THE DOCTOR TREATMENT OF OILS
WASTE CHEMICAL SOLUTIONS FROM SPECIAL TREATMENT AND SELECTIVE SOLVENT REFINING
FREE OIL FROM LEAKS AND SPILLS AND OILY WASTE WATERS
ACID SLUDGES, ACID WATERS, ALKALINE WATERS AND EMULSIONS FROM THE ACID TREATING, NEUTRALIZING AND WASHING OF OILS
CAUSTIC SLUDGES, WASTE CAUSTIC AND ALKALINE WATER FROM THE CAUSTIC TREATMENT OF OILS
FREE AND EMULSIFIED OIL FROM LEAKS AND SWEATING OVENS
CONDENSER WATER
WAX TAILINGS
CHEMICAL TREATMENT WASTES
OIL AND ASPHALT FROM LEAKS AND TANK CLEANING
CONDENSER WATER
SPECIAL CHEMICAL STORAGE
WASH ROOMS, RESTAURANTS, MECHANICAL SHOPS, POWER HOUSES, BARREL CLEANING, ETC.
FINISHED PRODUCT STORAGE
WAX PRODUCT STORAGE
ASPHALT PRODUCT STORAGE
SANITARY WASTES
GARBAGE
OIL FROM LABORATORIES, FLOOR WASHING, CUTTING TOOL EMULSIONS, BARREL WASHING EMULSIONS, ETC.
SPECIAL CHEMICALS FROM LEAKS AND SPILLS
SLUDGES FROM WATER TREATING AND BOILER BLOWDOWN
OIL FROM LEAKS AND SPILLS
ASPHALT FROM LEAKS AND SPILLS

Fig. 4—Wastes Produced in Petroleum Refining.

iron sulphide, silica, metallic oxides, soaps, emulsions, sulphonic and naphthenic acids, insoluble mercaptides and other suspensoids.[43] The wastes are usually highly and persistently odoriferous, have a comparatively high immediate and biochemical oxygen demand and, in addition, are toxic to many aquatic plants and animals in low concentrations.[42] Obviously, the disposal of this waste presents a difficult water pollution abatemen problem. If the waste waters are treated at their source to destroy the active constituents, the operator may have to modify his treatment methods for each different raw material being processed. When the waste waters are discharged into natural waters used as a source of raw water for drinking supply, it is necessary to use great care because they may cause serious taste and odor conditions.

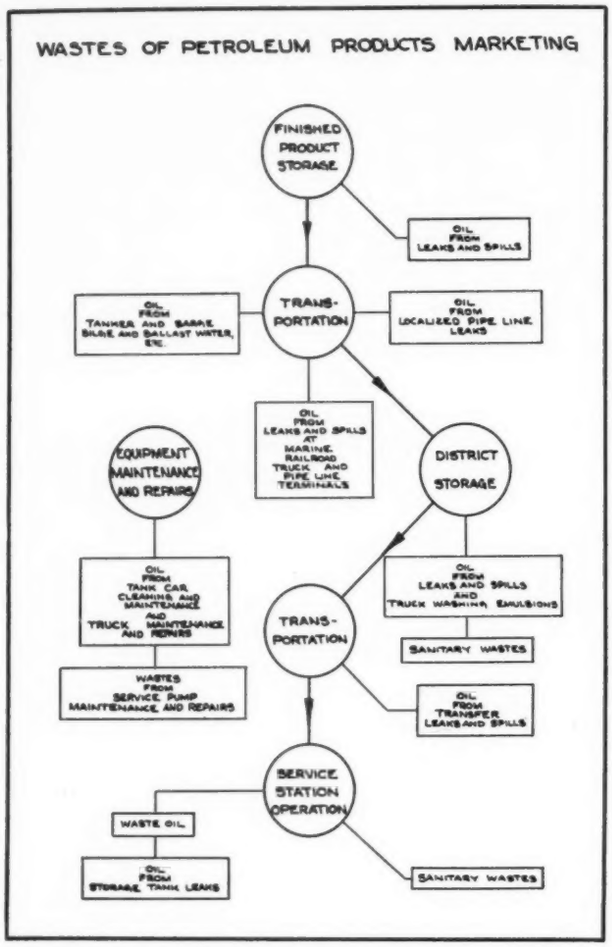
WASTES OF PETROLEUM PRODUCTS MARKETING
FINISHED PRODUCT STORAGE
OIL FROM LEAKS AND SPILLS
TRANS-PORTATION
OIL FROM TANKER AND BARGE BILGE AND BALLAST WATER, ETC.
OIL FROM LOCALIZED PIPE LINE LEAKS
OIL FROM LEAKS AND SPILLS AT MARINE, RAILROAD TRUCK AND PIPE LINE TERMINALS
EQUIPMENT MAINTENANCE AND REPAIRS
DISTRICT STORAGE
OIL FROM TANK CAR CLEANING AND MAINTENANCE AND TRUCK MAINTENANCE AND REPAIRS
OIL FROM LEAKS AND SPILLS AND TRUCK WASHING EMULSIONS
TRANS-PORTATION
SANITARY WASTES
WASTES FROM SERVICE PUMP MAINTENANCE AND REPAIRS
OIL FROM TRANSFER LEAKS AND SPILLS
SERVICE STATION OPERATION
WASTE OIL
OIL FROM STORAGE TANK LEAKS
SANITARY WASTES

Fig. 5.—Wastes Which Result in the Transporting and Marketing of Petroleum Products

The chemicals used as catalytic processing agents seldom create water pollution problems. They include compounds such as diethylene glycol, various metallic oxides and salts, solid-phosphoric-acid, and others.[23] These chemicals are generally handled with care because of their value and are usually regenerated and reused many times.[46] Consequently, it is only after prolonged use that they must be discarded. Under such circumstances they may be readily handled without causing water pollution problems. Some processes employ acids or other chemicals in solution under circumstances that require more or less continuous replacements. In such cases, the wastes may require corrective treatment prior to discharge but this is not general.

Coke and sludge removed from pressure equipment and towers at times of shutdown could cause serious pollution if handled improperly. The sludge is usually removed, collected and then burned in some firebox in the refinery. Coke may be handled in the same manner. However, coke is friable, so there is always a quantity of fines that is difficult to handle and may be washed into the drainage system. This petroleum coke is inert, insoluble and practically pure carbon. It will absorb oil, however, so that aggregates of oil and coke may be formed that have a specific gravity the same as water. These combinations of oil and coke cannot be removed by the plant separators. Consequently, small amounts of oil pollution may be caused by this type of combination of oil and suspended solids. Coke may also cause turbidity and a limited amount of shoaling. The problems of preventing water pollution of this type are reduced to a minimum by preventing these materials from reaching the drainage system.

Chemical Treatment

The most complex and most serious problems of waste disposal that confront the refiner are those associated with the chemical treatment processes. Chemical treatment, in the refining of petroleum, may be one or a combination of individual treatment processes. The most common types of chemical treatment are those using sulphuric acid, caustic soda, sodium plumbite solution or liquid sulphur dioxide and selective solvent refining, using phenols, furfural, chlorex, nitrobenzene, propane and other organic chemicals or combinations of chemicals.[28,46] Clays of various kinds are used in the form of suspensions or filters.

The wastes of these various refining processes may be grouped into five general major classes, i.e., acid sludge, acidulous waters, waste caustic solutions or sludges, waste plumbite solution and clay slurries. The organic selective solvent chemicals are not mentioned as a major waste for the reason that these materials are usually carefully conserved and, when possible, recovered.

The problem of acid sludge disposal is old in refining practice. The sludge is usually a black, tarry mass, varying widely in plasticity and viscosity. It results from the admixture of oil and acid for the purpose of removing undesirable constituents from the oil. The sludge contains oil, sulphuric acid, sulphonic acids, nitrogen compounds, complex hydrocarbons and others. Its characteristics give it the same polluting effects as oil, mineral acids, organic acids and shoaling materials. In earlier years the disposal of acid sludges created stream pollution problems in numerous localities, but acid recovery and other disposal methods have now greatly reduced water pollution problems from this source.

The acid treatment of oils includes the washing necessary to remove the residual acid. These wash waters generally contain less than 3 per cent of oil in the form of an oil in water emulsion and have the appearance of rich milk or cream. Emulsions of this type are very stable (some have remained stable for several years) and must be treated at their source. The treatment of these wash waters is a difficult problem because they may vary greatly in composition and characteristics with the refining of each different raw material.

The acid waters that are not emulsified are also difficult to handle. These waste waters are highly corrosive, so they must be handled in special equipment. Although these wastes may contain some constituents that are toxic to certain forms of aquatic life, their most serious effect

on receiving waters is that of lowering pH. In many cases the available dilution and buffer capacity of the receiving waters is sufficiently high that the wastes may be discharged without treatment. In other cases, controlled discharge or neutralization is necessary.

Caustic Wastes a Real Problem

The caustic treatment of oils produces a waste material that is discharged almost continuously and has many serious polluting constituents. The proper correction of waste caustic for disposal is one of the major problems of the refining industry. The characteristics and the quantities of the waste produced vary widely because of the characteristics of the crude oil and the methods of treatment. Caustic (NaOH) requirements may vary from about 7 to about 450 pounds per 1,000 barrels of oil.[52] The waste is a turbid, colored solution, usually red or red-brown, but sometimes yellow, green or blue, and usually has an intense, persistent, nauseating odor. Its chemical constituents include sodium hydroxide (approximately 0.5 per cent by weight), sulphides, sulphites, sulphates, thiosulphates, mercaptides, sulphonates, naphthenates, phenylates, nitrogen compounds and others.[43] Although the quantities of this waste produced are small, varying from almost none for the smaller refineries to a comparatively few hundred barrels per day for the largest refineries, the problems of disposal are great because of its characteristics. The waste, in general, has a high immediate and biochemical oxygen demand; it contains serious taste and odor-producing constituents, and it contains constituents toxic to some aquatic life. Waste caustics have been tested that had an odor threshold zone as high as 100,000,000.[45] This, of course, is much above the average. Many of the various known constituents of waste caustics and the waste material from the plant have been investigated and found to be toxic to certain aquatic plants and animals in comparatively low concentrations.[19,42,47]

The disposal of this waste is made more difficult by the fact that it originates at many different points. The concentrated waste generally originates at a single source, but the more diluted waste that separates from the treated oils in storage may originate at many different points.

The problem of treating this waste to remove its objectionable constituents, without prohibitive costs, has challenged some of the best minds active in waste disposal and pollution abatement work. Recently, definite progress has been made and there are now processes in use that in some cases are reasonably successful.[48] It should be mentioned at this point that the apparent solution to this problem, that is, the neutralization of waste caustic with waste acid or unused acid, is not practical in mosts cases because pH correction alone is not all that is desired and because the resulting condition of the waste and the end-products of reaction are decidedly undesirable.

The disposal of waste sodium plumbite solution is a difficult problem at some refineries. When comparatively large quantities of this material are produced, it is profitable to process the waste for reuse, but when small quantities are involved, the untreated or treated waste is allowed to flow to the plant drainage system. The waste is caustic, contains mercaptides and finely divided suspended lead sulphide, and is similar to waste caustic in many ways. The quantity of waste produced may vary from a few gallons per day for smaller refineries to 1,000 gallons or more per day for large refineries. Although the waste is a serious pollutant, it is apparent that the quantities produced are in many cases so small that it may be discharged without treatment under conditions of proven freedom from bad effects.

Clay in various forms, such as fuller's earth, bentonite and bauxite, are used in processing petroleum. When the clay is used as a filtering media and thoroughly burned to destroy its oil content, it may be disposed of as fill. The clay disposed of in this manner must be covered to prevent its distribution by wind. If this material is allowed to obtain access to natural waters, it may cause turbidity and shoaling. When finely divided clay is used in the form of a slurry, its disposal may present a difficult problem. If the clay is allowed to enter the drainage system, it causes shoaling in the sewerage system or separators and may increase the oil content of the effluent. It will also increase the turbidity of the plant effluent. This material has been satisfactorily handled by impounding and flooding the clay slurry, continuously removing the separated oil and intermittently disposing of the oil-free clay. Several other procedures have also produced satisfactory results.

Dewaxing and Wax Processing

The wastes from lubricating oil dewaxing and wax processing, other than those previously mentioned under acid and selective solvent chemical treatment, do not ordinarily cause serious pollution abatement problems. Waste waters from condensers, wax sweating ovens and similar equipment may contain wax and free or emulsified oil. These waxes and oils are generally readily removed by the plant separators.

One form of wax waste that does create a waste disposal problem in some refineries is that known as "wax tailings." This is a yellow or brown, thick, greasy material that comes from the still as the final product when oils are distilled to a coke residue. It is often heavier than water and readily emulsified. If allowed to reach a waterway, this waste may coat the bottom with a greasy layer that is destructive to all bottom life it contacts or covers. Fortunately, the material is not produced in large quantities and can be collected for additional processing or for destruction by burning. Consequently, few pollution problems are now caused by the disposal of this waste.

Asphalt Manufacturing

The wastes produced in the manufacturing of asphalt do not, ordinarily, create water pollution problems. The products of high melting point do not flow readily and usually solidify close to the point of their escape. Leakage of asphaltic crude oil and asphaltic products such as road oils, emulsions, roofing and coating stocks and other fluid materials may create oil pollution problems. The cleanings from asphalt product tanks could also cause water pollution. The construction of barriers and plant separators and the destruction of tank cleanings by burning have reduced pollution from these wastes to a minimum.

Special Chemical Manufacturing

The wastes incident to the manufacturing of various special chemicals are specific to the chemical produced and the processing involved. Since the nature of the chemicals manufactured and the wastes produced are specific to individual plants, it is not practical to attempt to discuss any of them at this time. In general, however, it may be said that waste products from special chemical manufacturing in the petroleum industry seldom causes serious water pollution problems.

Finished Product Storage

The storage of finished products may produce polluting substances from leaks and spills. Pollution from this source is negligible in quantity

and easy to correct. A well-designed and constructed drainage and separator system will afford a means of correcting such possible pollution.

Miscellaneous Activities

In addition to the wastes produced in processing and refining petroleum products, water polluting substances originate from associated activities. Oil may originate from miscellaneous leaks and spills, from the floor washing of shops, from laboratories, from machine shop cutting tool emulsions and from barrel cleaning and service pump cleaning and repairing establishments and garages that may be located at the refinery. Inert sludges may be produced by water treatment processes and boiler blow-down and sewage and garbage may come from wash rooms and restaurants.

Summary

The waste waters from petroleum refining and associated activities include a wide variety of constituents of both major and minor importance in creating water pollution problems. The wastes originate at many different units and at many different locations. These conditions make it necessary for the refiner to provide a comprehensive and more or less extensive sewerage system for waste water collection and transportation. The characteristics of some wastes make it necessary to provide waste recovery or waste treatment facilities at their origin. Others, obviously, may be discharged directly to the plant sewerage system. However, these wastes usually cannot be discharged direct to the receiving natural waters. The nature and extensiveness of the activities within a refinery and the nature of the material being handled makes it necessary that practically all waste waters and all surface drainage from the refinery pass through oil traps or separators before being discharged to natural waters.

Marketing

The marketing of petroleum products (Fig. 5) may be considered as including the transportation of the products to convenient storage points from which they may be delivered to the consumer readily and economically, the storage of the products, the transportation to the consumer, and the sales or service station. The Transportation of the finished product is accomplished by tanker fleet, barges, tank cars, tank trucks and pipe lines. The finished product is stored in steel cans, barrels or tanks. In providing these facilities for transportation and storage, thousands of dollars have been spent to develop equipment that will reduce loss by leakage and rupture to an absolute minimum. Despite the efforts of the marketer to reduce losses and thereby increase profits, small quantities of finished products are lost.

The loss of finished product and the occurrence of wastes from various marketing operations may cause oil and other pollution. Oil pollution could result from loss of finished product from leaks in transportation, transferring and storage equipment, from spills incurred during the transferring of product from transportation facilities to storage facilities or vice versa, from tank and tank car cleanings, from bilge water or ballast water of tankers and barges, from truck maintenance, from truck washing, from sales station operations and other activities.

Oil pollution from leakage of transportation facilities may be general in distribution, but is usually negligible in quantity for mobile units but can be relatively serious and localized for pipe lines. Pollution at marine terminals, railroad sidings and truck terminals has been appreciably reduced by providing oil separators and leak or spill intercepting facilities for transferring equipment. Although only small quantities of wastes are involved, pollution from storage and truck distribution points is sometimes serious because the receiving streams may be small and noted as "trout streams" and used for other recreation or raw drinking water supply.[49] Free oils from leaks and truck maintenance and emulsions of oil, dirt, road tars, etc., from truck washing could in these cases cause serious oil pollution conditions. The greatest factor in pollution prevention at these marketing properties is the establishment of good housekeeping procedures[50] and the construction of oil retaining and emulsion-breaking equipment or the establishment of other effective means of disposing of these wastes. The establishment of treatment and disposal methods and procedures is complicated by the wide variations in the character of the involved products.

Oil from locations connected to city sewers has at times caused operating difficulty at municipal sewage treatment plants.[51] Pollution from these sources may be eliminated by the installation and proper care of effective separating devices. However, after the oil has been retained and oil pollution prevented, it is necessary to dispose of the collected oil. The mechanics and economics of transferring and disposing of these small quantities of waste oil is perhaps the greatest waste disposal problem of the marketing industry.

Oil leaks from underground storage tanks and pipe lines have in some isolated cases polluted ground water used for drinking water supplies. The loss of oil causing such pollution is very costly. Consequently modern construction methods and modern corrosion prevention materials and devices have been developed to eliminate pollution from these sources.

Waste waters containing paint, paint remover and oil may originate from service pump maintenance activities. These wastes seldom cause serious problems because they are small in quantity and generally originate at locations where waste disposal facilities are available.

In addition to the problems of disposing of oily wastes, there are problems of sanitary waste disposal. Although the quantities of wastes involved are small, local conditions often make it necessary to construct costly sewage treatment facilities for the protection of public water supplies and the protection of those using waters for recreational activities.

Summary

In recapitulation, the water pollution abatement problems of the petroleum industry, which was arbitrarily made to include all activities from the drilling of the well to the disposing of used oil by the consumer, may be classified as those incident to Production, Refining and Marketing. The major pollution abatement problems of Production include the prevention of oil pollution and brine pollution; those of Refining include the prevention of oil pollution and pollution by wastes having high oxygen consuming characteristics, intense and persistent taste and odor-producing qualities and toxic effects on aquatic life, and those of marketing include the prevention of oil pollution and waste oil disposal.

The wastes of the industry originate as the result of many and widespread activities and operations. They vary widely in their characteristics and their effects on receiving waters. In a general discussion of this kind it has not been possible to give detailed information on their type, quantity and characteristics, because space would not permit detailed discussion of influencing factors such as the natural conditions encountered, the raw materials processed, the specific processing methods involved, the nature and specifica-

tions of the final product, etc. Consequently, it has been possible to discuss only the general characteristics of those wastes of most general occurrence.

In considering the foregoing discussions it is apparent that the waste disposal problems of the industry are many and varied, because of the variety of wastes produced, the varied characteristics of the wastes, the non-uniformity of the characteristics of similar wastes from plant to plant and from day to day at the same plant, the changes in operation methods required by competition and the production of new or improved products, and the characteristics, quantity and uses of the receiving waters.

In surveying the task that is involved to prevent water pollution, the thought may occur that there would be a continuous loss of ground and increase in pollution. This, however, is not the case. Although pollution still exists to a serious degree in some cases, there is no section of the country that does not show improvement in the waters affected by the Petroleum Industry. The advances made could not have occurred without a conscientious effort on the part of the industry. This concerted effort to abate water pollution has been put forth, in all but a few cases, because the industry as a whole is conscious of the value of the Nation's water resources and the need of water resource protection.

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INDIANA SECTION

Holds 34th Meeting in Indianapolis, April 24th and 25th

THE 34th Annual Meeting of the Indiana Section of A.W.W.A., with a registered attendance of 212, proved up to the usual standard for Indiana meetings. The Program Committee, however, was subject to criticism for allowing the program to become so overcrowded that parts of it suffered from rushing portions of papers, and leaving practically no opportunity for questions or free discussion.

Governor's Address a Feature

A high spot of the meeting was the luncheon attended by the Governor of Indiana—the Hon. Henry F. Schricker—who made an address that indicated that Indiana's top executive knows considerable about, and has a decided interest in, public health and sanitation; and, also, has a first hand appreciation of the importance and the work of operators and managers of water works and sewerage systems.

Secy-Treas.
H. Horstman, Supt. Water Distribution Pub. Service Co., Indiana Indianapolis

New Vice-Chmn.
E. F. Kinney District Mgr. W. & T. Co. Indianapolis

The Governor's talk was something more than a pat on the back, or welcoming speech. Referring to water works men as specialists who seem to always know more than they claim, he said that they were indispensably valuable citizens and renderers of community services of the highest order, as also were those charged with sanitation which he had met. That these were men in the habit of thinking into the morrow and planning in advance, made those of the water works and sewerage profession of even greater potential value to the community and the nation than usual at this particular time. Requiring adequate preparedness for what might come, and cooperation in facing the national emergency, advance planning would prove the keystone.

It turned out that the Governor, while Lieutenant Governor, had at first hand learned the ways and the thinking of water works and sewerage men in emergencies, when on the job in flooded-out Evansville and other Indiana and Kentucky communities on the Ohio during its long to be remembered rampage.

Chairmen

(Retiring)
L. R. Mathews, Supt. Filtration Plant Ft. Wayne

(Incoming)
L. A. Geupel, Supt. Water Department Evansville

Jones on Public Relations

The annual dinner speaker was C. W. Jones, General Superintendent of The Wm. H. Block Co. of Indianapolis, who made a reputation in his public relations and employee training work. Mr. Jones pointing out that success in dealing with the public is based on ever remembering the importance of those trivialities which the emotional or imaginative customer so effectively magnifies. Employee courtesy under all circumstances, remains the first requisite in every instance, and will reduce complaints by 33⅓ per cent at least. The personnel manager's job starts with effective choosing of employees and the equally important job, their training. The successful manager must have a genuine affection for his employees and a regard for people in general. His job is to set the employee a good example and then (the hardest of all), let him alone. In other words, cautioned Mr. Jones, train well and expect much of the employee, but don't nag. His remarks were, in a sense, a way of saying that good public relations must begin at home.

Host
H. S. Morse Gen. Mgr. Indianapolis Water Co.

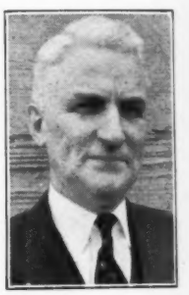
"Hizzoner"
H. F. Schricker Governor of Indiana

The after dinner entertainment feature was the singing of the negro quartet from Foster Hall, a memorial to the Indiana negro composer Stephen Foster, established by Eli Lilly of Indianapolis.

Fuller Award to Laux

The George W. Fuller Award was voted to Paul C. Laux, Sup't of Filtration at Anderson, Ind., the citation read by Committeee Chairman John C. Ford, being, "In recognition of his pioneer work and constructive leadership in the district meetings and operator training program of the Indiana Section; and his development of the flash test for the control of break-point chlorination."

Voted Fuller Award
Paul C. Laux Supt. Filtration Anderson



National Director
Cecil K. Calvert San. Engr. & Supt. Filtr. Indianapolis Water Co.

Officers Chosen

Officers named for the ensuing year are:

Chairman

Louis A. Geupel, Sup't of Water, Evansville, Ind.

Vice-Chairman

Ed F. Kinney, Distr. Mgr., Wallace and Tiernan Co., Indianapolis.

Secretary and Treasurer

Herman G. Horstman, Sup't, Water Distribution Division, Public Service Co. of Indiana, Indianapolis.

Ass't Secretary

P. H. Reardon, Sup't of Water, Marion, Indiana.

The National Director is Cecil K. Calvert, Sanitary Engr., and Sup't of Purification, Indianapolis Water Co.

A. W. W. A.'s President in Action—"N. J. H." and Audience
(Particularly do we like the tilt of the "seegar"—2nd from right.)

Technical Sessions

Chairman—L. R. Matthews, Ft. Wayne, presiding.

(Note: Because of space limitations, we shall not be able to report the Technical Sessions as fully as we should like to. It will be necessary therefore to be very brief with some of the papers—in particular those which would appear to be of limited general interest. We regret the need for curtailing any part of this report but necessity dictates in this instance.—L.H.E.)

The opening paper, presented by *G. F. Fix,* Ass't State Geologist, comprised a review and summary of ground water conditions and problems in Indiana, which takes only 300 m.g.d. (principally in the North) from this source. Mr. Fix pointed out that the expense of treatment required for ground water makes surface waters more economical as a rule in Indiana.

In the discussion, Professor Fred Serviss (Purdue) called attention to the need for State control of ground water resources and protection against abuses; urged cooperation of water utility managers in recording and reporting ground water conditions.

The Chairman reported that House Bill No. 93, providing for systematic survey and study of ground water conditions of Indiana, although endorsed by the Section, had not yet been reported out by the House Committee.

"Water Works Management" by Louis R. Howson, Consulting Engr., Chicago (President-Elect of the Association).

Mr. Howson's Indiana paper was as thoroughly prepared and as expertly presented as is usual with his papers. He pointed out that there was no such thing as a "Static Water Works" because the system and management was always found either going forward or backward.

In proper maintenance, good practice called for an expenditure for betterments amounting to between $1.00 and $1.50 per capita served, such being roughly 25 per cent of gross income. In financing, the bond route was the far less favorable method to the pay-as-you-go plan of maintaining a betterment fund from operating income. The latter plan had cost just about 60 per cent of that of issuing bonds and amortizing. Outstanding examples of the pay-as-you-go method were those of Milwaukee, Racine and Louisville, Ky.—the scheme proving the best possible checkmate to the diversion of water funds, and also had allowed rate reductions otherwise impossible. In practical rate-making the basis should be equity, tempered with expediency, rather than flirting with disaster, which is invited by too highly theoretical considerations in rate making.

Dignitaries
The Mayor of E. Chicago
Frank Migas

The Mayor of Crown Point
W. Vincent Youkey
(Exec. Secy. Indiana Munic. League)

Judge E. C. Henning, Chmn.
Evansville's Water Board

As to type of management, Mr. Howson pointed out that the City Manager form had proved ruinous where the manager, inexperienced as a water works operator, had assumed too much responsibility in reorganizing and directing water works operations. By far the most happy and successful management had been that given by Water Commissions or Boards, both as to efficiency and economy. Likewise as to continuity of management and operating personnel.

Mr. Howson said that the live and awake operating manager would have rather complete records maintained, and these studied. Only thus could costs on individual operations at one place be compared with another, and dollar leaks detected and stopped. He cited instances of 100 per cent difference in meter repair costs and 200 per cent in office costs—such differences representing $250,000 yearly in cities of the same size. Checking pumping efficiencies at regular intervals reveals important possible savings should the observed efficiency drop to 75 per cent. And, as to unaccounted for water; what did it constitute? Only well managed properties could boast 85 per cent accounted for (difference between metered water billed for and that entering the system) and even 80 per cent is considered acceptable. As to ownership of consumers' meters, Mr. Howson said that it had proved worth 6 per cent added income for the utility, rather than the customer, to own the meters.

Frank C. Jordan, Secretary, Indianapolis Water Co., interested in Mr. Howson's figures, was proud to report that his company collects from 86 to 87 per cent of the water pumped and receives $11,000 annually from the city for fire supply water, netting 90 per cent of the water that enters the system being paid for.

Mr. Howson added that allowance of not more than 0.5 per cent of water pumped as fire requirements was ample. On the other hand, the regular street washing and sewer flushing represented important increments. For worth while records it would be necessary to have meters on every service line, whether the water be paid for or the service be considered free.

Utility Coordination in Emergencies—by Louis A. Geupel, Sup't Water Department, Evansville, Ind.

Mr. Geupel, Chairman of the Section's Committee on Emergencies, in an interim report reviewed the work of the committee since organization within the year. The State has been districted, the 15 districts being the same as those set up by the State Department of Health. A Section Chief named for each district has made contact with water supply managers in his district, and each has been questionnaired concerning emergency equipment, spare supplies on hand, and ability to obtain equipment and materials. The information supplied, when analyzed, indicates that most Indiana utility managers have been planning for future possible needs and are experiencing no serious delays in securing materials.

Mr. Geupel then read the Committee's recommendations to water works managers, regarding preparedness in the matter of getting entrenched with stocks of maintenance items such as bearings, spare parts for valves, meters, chlorinators, hydrants, dry feed machines, etc. Stocks of materials and equipment should be amplified above normal—such for instance, as pipe, valves, hydrants, fittings and chemicals that may be delayed due to strikes, defense demands or bogged-down transportation facilities.

The Committee recommends that each manager obtain a record of what power equipment is available in contractor's hands (and elsewhere) in his city or area, in case of need for shovels, compressors, pumps, etc.

The Committee recommends that every community organize its own committee of utility heads, for coordination of efforts and aims, plus the chief of police, the fire chief, building commissioner, director of public works, sup't of sewerage, city engineer. The discussions and plans of such committee is to be in closed session in a room where complete maps of all water, power, gas and sewer lines are kept for easy reference. Upon decision of procedure and plans orders, agreed to by the majority of the members, are to be issued by the Mayor.

The Committee stresses the fact that in emergencies the "little black book" type of records of piping and valve locations is the sort of thing that comforts the enemy or the saboteur. It urges that good maps and records of worth be made without delay and that every foreman be supplied such maps and records of valve and hydrant locations. These he should memorize as nearly as possible but always refer to for confirmation. Also, that promiscuous plant visiting be prohibited and the operating personnel be particularly scrutinizing of strangers.

Mr. Geupel stated that this matter of suggesting interchange of information concerning emergency equipment and supply stocks on hand, between water works men within reasonable distances of each other, constitutes a mutual aid policy which has value in peace as well as in war times. It was his thought that cooperation in this manner would bring closer friendship and many advantages in general. However, the danger to look out for is that should "Bill" find himself in dire need of a fitting that "Tom" had recorded as on hand, only to learn on the 'phone that "Tom" has in the meantime had to use it but failed to re-order promptly, the system of mutual assistance will fail of its objective utterly.

Mr. Geupel, in closing, said that strikes tying up steel pipe production of National Tube and Youngstown Tube were getting close to home in the water supply field, and indicated the need for water works men to get ahead on supplies.

Programmers

La Verne Trentlage
Supt. of Meters—Elgin

Charlie Link
Supt. of Water—Elkhart

H. W. Niemeyer
Supt. Distribution
Indianapolis Water Co.
(Chmn. Com. on Arrangements)

Programmers

T. E. Milligan
Complaint Engr.—Ft. Wayne
(Chmn. Com. on Meter Settings)

John L. Ford
Ford Meter Box Co., Wabash
(Past-Chairman of the Section)

J. C. Vaughn
Supt. Filtration—Hammond
(Chairman Program Committee)

"Our Job in Time of Stress" by W. W. Brush Editor, "Water Works Engineering," New York City.

Mr. Brush pointed out the need for surveys and check-ups to make certain of sufficiency of supply, dependability of power, treatment facilities and distribution. Of particular importance too was a check-up on the dependability of manpower—i.e., employee loyalty, without which other defense measures might be all in vain. He said that "know your distribution system" was the word of the day. That meant effective valving, with all units checked and rechecked for dependability of functioning.

Mr. Brush showed lantern slides revealing results of bombs in Spanish cities and emergency equipment for making main repairs, portable steam boilers, etc.

Managers' and Supts.' Special Session

F. A. Schaefer, Chairman, Technical Committee, Presiding.

The Indiana Section has a Technical Committee composed of a number of sub-committees designed to function somewhat on the order of the Water Works Practice Committee of the parent association. The Special Session for Managers and Superintendents comprised in large part a review of progress by several of the sub-committee chairmen — plus a couple of "Round Tables."

"Frost Penetration" by J. D. Richetta, Ind. Dept. of Health (chairman).

Reported plans to set up stations and obtain records of frost penetration in various soils. A survey revealed frost depths in the record year of 1936 running to 5 feet as maximum. Following the scheme proposed by H. U. Fuller at Portland, Me., a frost depth prediction table, based on observed temperatures has been prepared for testing its applicability under Indiana conditions next Winter.

"Paints and Painting," Prof. W. E. Howland, Purdue University (chairman).

Reviewed progress on proposed production on "Manual on Paints and Painting." Preliminary chapters deal with the matter of where paint is needed, include a glossary of terms and existing A.S.T.M. paint specifications. The Chairman referred to the excellent work of W. J. McClenahan of the Chicago Sanitary District, in establishing specifications for sewage works paints. Such had been instrumental in boosting quality, bringing down prices, and removing the bunk from manufacturers' claims. The Chicago reports and specifications are being freely drawn from for the proposed manual, said Mr. Howland, who finds it a problem to separate specifications from manufacturers' claims.

"Meter Settings"—T. E. Milligan, Fort Wayne Water Dept. (chairman).

Presented a completed report which concluded that meter settings at the curb are preferable to basement settings because the advantages outweigh the disadvantages, whereas the reverse is true of inside settings. Outside advantages include—(1) less tampering; (2) one call for reading; (3) no need for property entry; (4) less cost per reading; (5) assured protection of meter.

In a box setting the recommended minimum depth of meter top below ground level is 18 inches, when con-

(1) *Henry J. Draves, Supt., Michigan City, and L. G. Bradford, Worthington-Gamon Meter Co., Chicago;* (2) *T. E. Milligan, Complaint Engr., Ft. Wayne, and L. P. Lessard, Sales Engr., Johns-Manville Co., Chicago;* (3) *Leo V. McDonald, Supt., Princeton, Ind.; C. W. Stewart, Darling Valve Co., Williamsport, Pa., and J. J. Hawley, Hersey Meter Mfg. Co., Chicago;* (4) *Jo. Davidson, Reilly Tar & Chem. Co., Indianapolis, and Larry Lingnor,* WATER WORKS & SEWERAGE; (5) *Archie Frew, Chemist, Vincinnes, Ind., and A. C. Gutsch, Supt. (35 years of service) at Washington, Ind.*

sidering frost protection and readability of register taken together.

The Box. Terra cotta gives best insulation, concrete next; diameter to be 18 to 20 inches for ⅝ inch and ¾ inch meters; bell end down and bottom of pit 12 inches below maximum frost penetration; meter risers near center as permissible and not closer than 3 inches of walls. The report points to the desirability of a no joint box. To this end "Transite" pipe had met all specifications and proved easy to work with when cut to 4 foot lengths from a 13 foot pipe, each length weighs but 143 pounds as against 240 pounds for vitrified pipe; has good insulating properties and no joint; singde disadvantage is cost. Clay should be tamped in around the box for added protection. The use of a single or double lid box is subject to debate, since there are advantages and disadvantages. As to meter setting devices, such is a matter of individual preference.

The service pipe should be at least 3 inches below bottom of meter box; the curb cock either inside or out of the pit, best practice being to have one valve outside on the service and the other inside at the meter but on the main side.

Inside Settings. The meter should be set horizontal for greater registration accuracy and longevity of parts, using special setting connections if need be. Setting meters close up to entrance of service line through cellar wall eliminates temptation in consumer tapping of line ahead of meter. Inside meters should be valved on both sides to allow removal without water spillage or back syphon action in draining the piping system. The report emphasizes the importance of having proper tail pieces, spaced proper distance apart to preclude damage and inconvenience when removing the meter.

Meter removal or setting by plumbers should be prohibited, and effective seals always employed to preclude tampering.

"Maintenance Manual" — Clyde Williams, City Engr., South Bend (chairman).

Reviewed many questions sent out to superintendents, looking toward assembly of material for a "Maintenance Manual" of greatest value. Space does not permit listing all of the chapters planned. It is evident that the material collected will be useful in the "Distribution Manual" which is being planned by the A.W.W.A. as a companion to the "Manual on Purification."

"A 100% Meterization Program that Paid" by Everitt Robbins, Supt. of Water, Scottsburg, Ind.

Mr. Robbins related experiences with a delayed meterization program revived to secure a 100 per cent metered Scottsburg, resulting in a 30 per cent reduction in pumping, plus a 10 per cent revenue pick-up. To secure the revival of meterization the public were sold through the local newspaper on the need for conservation. Leaflets supplied by Ford Meter Box Co. also were used to good advantage along with water bills. Hand bills were used to warn consumers regarding leaks, and suggested methods of checking for unsuspected leaks. The combination program of leak corrections and meters had netted the 30 per cent pumpage reduction against 20 per cent anticipated, taking 3 months to accomplish after metering had been completed.

Value of Foresight in Operation

(A Round Table)
John L. Ford, Leader.

Mr. Ford illustrated the value of foresight by citing the case of the Paris, Ill., water plant that burned down, only because someone had overlooked providing a fire-hydrant or sprinkler system for the plant.

Jack Gordon, Sup't. at Rochester, Ind., advocated the value of visiting neighbor plants and finding out what they have in the way of materials that may be needed some day for repairs. Exchange information on supplies and when emergency strikes lend equipment and help too, was his "thought of the day."

Chas. Broadbeck, Sup't. at Decatur, Ind., seconded Mr. Gordon's suggestions when advocating friendliness between neighbor managers and cooperation between various City Departments, at home, in preparing for emergencies at which time dependable and efficient help was as important as needed equipment.

Glen Gorman, Sup't. at Lafayette, Ind., related thawing experiences and described a home-assembled thawing generator set, good for 1,000 amps. at 15 volts, with which 105 services had been successfully thawed with 600 amps. at 15 volts. The thawer had cost only $125, consisting of a discarded auto-motor and a generator.

Furnishing Water Service Beyond Corporate Limits

(A Symposium)

"Extensions to Distribution Systems," by F. R. Berry, Ass't Chief Engr., American Water Works and Electric Co., New York, N. Y.

Mr. Berry's noteworthy paper, discussing factors to be considered in making extensions to distribution systems, was read by Wm. C. Shoemaker, Manager, Richmond (Ind.) Water Co. The opinions and conclusions of the author were based on studies of 10 year periods following extensions in 19 plants, and in considering long time effects on net costs, rather than mere immediate results. Involved are the primary factors of (1) increase in operating and maintenance expenses; (2) the added investment carried. These two factors were discussed separately.

In the studies made, Mr. Berry concluded that the only true evaluation of the effect of the added customers on operating expenses is that had by considering the "operating ratio." The last was defined as the relation that operating expenses *alone* bear to gross earnings, expressed per cent-wise. Taxes and depreciation are excluded because these items vary from time to time and have no direct bearing on the effect of adding additional customers.

The striking fact brought to light by Mr. Berry's studies is the finding that for the 10 year periods the *operating ratio remains relatively uniform regardless of the rate of extensions* to the system to serve added number of consumers. This be-

(1) W. A. Oeffler, Mgr., Jasonville (Ind.) Water Co., and Clyde Williams, City Engr., South Bend; (2) J. J. Hawley, Hersey Meter Co., Chicago, and Leo V. McDonald, Supt., Princeton, Ind.; (3) H. A. Holiday, Asst. Supt., and W. M. Rhodes, City Clerk and Treas., Paoli, Ind.; (4) H. G. Ford and Ed. N. Shelton, Tennessee Corpn., Atlanta, Ga.; (5) Hayes Kuhns, The Leadite Co., Philadelphia, Pa., and M. A. Stearns, Mgr., Kokomo (Ind.) Water Co.

ing the case, the additional operating expenses expected from making extensions can be determined equitably by applying the operating ratio (then existing) to the estimated aditional annual revenue expected. In this case the operating ratio must of course include taxes and depreciation. Since local conditions so affect the operating ratio, this value will be markedly different for various localities and it becomes a case of figuring the net costs of providing extensions for the individual property and expected return on the investment.

Turning then to consideration of the added investment required, Mr. Berry makes a point of the fact that adding customers entails more than the mere footage of new main, service lines, meters and fire hydrants. When the cumulative total reaches a certain point it entails eventually increased supply, more pumping and treatment facilities. In considering the proper amount on which a return should be made it is necessary to take the ratio of the value of the distribution system proper to that of the entire system, requiring a reasonably accurate record of the value of the component parts of the system. As an illustration a hypothetical case was cited in which the distribution system represented 51.7 per cent of the value of the complete works.

Now, said Mr. Berry, when the operating ratio and the per cent of total investment represented by the distribution system is fairly accurately known it is a simple matter to determine what return should be had on the *complete* investment in the extension, and not the mere cost of labor and materials.

Operating ratio = 54% of gross operating revenues, as that needed to cover all operating expenses.
Available Return = 46% of gross operating revenues.
Distribution Facilities = 51.7% of value of complete system.
Proper Rate of Return = 6% as the reasonable figure.

The calculation becomes

$$\text{Return Needed} = \left(\frac{.06}{.46 \times 51.7}\right) = 25.2\%$$

In other words, the utility should earn 25.2 per cent annually on the bare cost of the extension, if the added *complete* operating expenses are to be covered, plus the 6 per cent return in the clear on the cost of the extension and the necessary part of the supply facilities behind the extension of piping.

Mr. Berry pointed out that unless the outlying consumer pays this fair cost of extensions to serve them, the older customers will suffer by being forced to stand rate increases to pay the added costs of extensions.

Mr. Berry then discussed the general rules of New York and New Jersey Public Service commissions pertaining to allowable charges for extensions. One plan in New Jersey is that of requiring the water utilty to stand the cost of extension but permits recovery of 28.6 per cent of the new money invested therein. The New York rules require that the water utility pay all costs for the first 75 feet of line, and above that the applicant pays a surcharge of 9 per cent of the cost of a 6 inch main regardless of the size installed. When the total revenue from the extension amounts to 25 per cent on the gross cost of a 6 inch main the surcharge is cancelled.

"Experiences in Main Extensions in Hobart, Ind." by E. D. Anderson, Vice-Pres., Northern Indiana Public Service Co., Hammond, Ind.

Mr. Anderson related a case of a Hobart ordinance ordering a main extension costing $48,000, which the Public Service Commission had held unreasonable in this community of only 5,800 people. A later ordinance required an extension costing $13,-219. Even with a contribution of $75 per service by each customer (returnable in service) the deficit was better than $4,000.

"Legal Liabilities Involved Under Indiana Law" by Nathan Levy, Attorney, South Bend, Ind.

Mr. Levy pointed out that the Indiana regulations require a 50 foot extension per new tap, at no cost to applicant. If the extension is longer and revenue is sufficient to pay for the installation in a 5 year period no surcharge is permitted.

In South Bend there are 6 different contractural plans available to those requesting main extensions, but regardless of the plan selected for payments the extension must be wholly paid for during the first 5 years. When such is accomplished all moneys deposited as guarantee is returned—but, without interest. The 6 methods of paying for extensions have all been based on reasonability as the primary consideration, while avoiding the factor of political "expediency" had constituted an added problem with which the privately owned utilities do not have to contend.

E. C. Henning, also an attorney, and a member of the Water Board of Evansville, stated that Evansville has many extensions running to $25,000. The method of financing involves an estimate by the superintendent. If acceptable, a contract is drawn which requires a deposit completely covering costs, if the area served is without the city limits. There are no guarantees of pressures or quantity of water, and if the area is taken into the city the extension automatically becomes the city's property without refund of any of the cost to the applicant.

"Ozonation at Whiting" by James Bartuska, Sup't. of Water, Whiting, Ind.

Confronted with oil refinery wastes, sewage and a variety of industrial pollution, Mr. Bartuska remarked that Whiting's Water Purification Plant was in truth as much a waste and sewage treatment works as a water purification plant. With Threshold Odor values of 300 or better at times and chlorine demands mounting at times to 40 pounds m.g., Whiting had decided to install ozonation for the purpose of destroying tastes. The application is made to the raw water, thus eliminating the need and expense for aeration. For sterilization the filter effluent is chlorinated in the customary manner.

Mr. Bartuska described in some detail the equipment comprising the 5 ozonators providing 5 to 10 pounds of ozone each and the deep downflow ozonizing chambers containing Aloxite tubes at the bottom to diffuse the ozonized compressed air under pressure of 8 lbs. In addition to the ozonators and ozonizing tanks the

(1) W. H. Durbin, Mgr., Terre Haute Water Co.; (2) J. B. Laramy, Sales Engr., Worthington Pump & Mach. Corp.; (3) M. H. Schwartz, Supt. and Genl. Mgr., Vincennes, Ind.; (4) Albert Vinick, Supt., East Chicago, Ind.; (5) H. C. Ohge, Indiana Rep., Graver Tank Co., E. Chicago; (6) C. E. Stewart, Mgr., Muncie (Ind.) Water Co.; (7) C. D. Adams, Supt. of Treatment, Public Service Co. of Indiana, New Albany, Ind.; (8) Jack Gordon, Supt., Rochester, Ind.; (9) Fred H. Brune, Distr. Mgr., Rensselaer Valve Co., Chicago.

installation comprises air compressors, air cleaners of the electrical precipitation type and air dryers containing activated alumina regenerated by gas heating. The installation of the air supply and ozone production equipment involves 175 sq. ft./m.g. of treatment capacity.

Mr. Bartuska said that operation, begun in July, 1940, had been simple. Push button control provided six different rates of ozone production by each unit, the ozonated air containing 0.5 to 1 per cent ozone by volume is produced with a silent discharge of 16,000 volts. The dosage control involves tests with orthotolidin for residual ozone (O_3). Employing chlorine standards, the color ratio is 1.5 p.p.m. apparent residual chlorine represents 1.0 p.p.m. residual ozone. He pointed out that in Whiting raw water the residual rapidly dissipates.

Operation since October 1940 on routine basis had given some facts of interest. The ozone demand had varied between a high of 43 lbs./m.g. and low of 5 lbs./m.g. to secure the temporary residual sought, the average dosage for the winter 6 months being 25 lbs./m.g. With the raw water varying from 66 to 275 T.O. number, the finished water had run 6 to 21 in T.O. values, the average being 11 and representing an average T.O. value reduction of 68 per cent.

However, the chief value had been in taking the T.O. number down from the peak values, to leave only the 21 value, and in the levelling off of chlorine demands to peaks of 8 lbs./m.g. Except for such peaks the demand has varied between 2½ and 5 lbs./m.g. in the filtered water during ozonation. Concerning bacterial efficiency, ozone had reduced the index of the raw water by 95 per cent and final chlorination had been depended upon to complete the job.

Costs—When it came to analyzing costs Mr. Bartuska was hurried, due to the expiration of time, and little was heard concerning this phase of operations. However, it was revealed that the saving in chemical bills attributed to ozonation had been estimated as 18 per cent in alum, 33 per cent in chlorine and 51 per cent in ammonia when comparing operations since October, 1940, and a similar period the year previous. In dollars the total savings averages $3.50 per m.g. What the cost of installation or that of operating the ozonation equipment ran to was, to many, disappointingly not revealed in the presentation. We understand, however, that the paper when published will disclose such information.

Unfortunately, there was no discussion or time for questioning of the speaker, due to a crowded program running behind schedule.

"Practical Considerations in Maintaining Small Meters Accurate and Sensitive," by LaVerne Trentlage, Sup't of Meters, Elgin, Ill.

Mr. Trentlage, in advocating greater attention to maintaining accuracy and sensitivity in service meters, named what he considered as three sins in meter testing practice. These are:

(1) Testing at the so-called "full flow of 20 g.p.m. when a domestic meter is rarely called on to register such a rate. By investigation, as a matter of fact (see table following) less than 1 per cent of the total domestic consumption is drawn at rates above 6 g.p.m and more than half the consumption passes through the household meter at a rate of only 4 g.p.m. So why waste time and effort testing at rates above 10 g.p.m.?

(2) Failing to test at the ¼g.p.m. rate. This, because almost 14 per cent of the water passing the average household meter passes through it at rates of ¼ g.p.m. and less—see table of "popular" flows.

(3) The third sin is the general lack of proper testing equipment for making the low flow tests accurately and decisively. For instance, many still depend upon the orifice for low flows, whereas the much more reliable measure for flows of 2 g.p.m. and under is a volumetric measure in a calibrated vessel, or the use of glass funnels. The error of a worn orifice will surprise anyone comparing the two schemes, whereas the "port" of the dependable glass funnel never changes.

In regard to testing at various rates, Mr. Trentlage advocates testing for accuracy particularly at the demand flows which are most prevalent for the class of service metered. Such flows, termed "popular flows," were cited as the following for the average residence:

Demand Rate G.P.M.	Per Cent of Total Registration
10-12	0.7
6	*14.7
4	*52.4
2	*11.8
1	5.0
½	1.8
¼	†4.5
Less	†9.1

*Popular flows.
†Leaks and waste.

Example: Of total water used in home 67.1 per cent appears on the average to be drawn at the 4 and 6 g.p.m. rate; 11.8 at the 2 g.p.m. rate, etc. *But*, 32.2 per cent of the whole use must be recorded at rates of 2 g.p.m. and under.

The latter is what Mr. Trentlage emphasizes in advocating the importance of sensitivity and accuracy on minor flows as well as on the "popular" flows above the 2 g.p.m. rate. Axiomatic, he said, was the fact that income from metered water sales could only be proportionate to the accuracy of the meter over the "popular" flows, comprising the important percentages of the total volume used through the service in question.

Then Mr. Trentlage reviewed experiences in a test case of 181—⅝ inch meters of the open gear train type, not tested for several years. In this lot he found 51 per cent dead on ½ gallon flows and less. These were put in good condition, tested on *popular flows only* and returned to service. A check up indicated

that $4.54 per quarter per account had represented loss of income on low registration through these meters of leakage on consumers' premises. Interestingly it was revealed that $4.00 of this total could be explained by leakage through toilets alone. In 11 months increased income paid for 100 new ⅝ inch meters—$1,200.

A study made of recording charts from 31 services running high bills disclosed the following facts. Leaks of all kinds accounted for $13.00 average/quarter for the 31 cases studied, of which $10.00 could be charged to leaking toilets. Seventy-one per cent of the cases showed leak recording of under ¼ g.p.m. and 29 per cent above. The average toilet leak proved to be ⅓ g.m.p., amounting to 42.768 gal./quarter. It could be safely said that 75 per cent of all toilets leak at some time during the year.

In comparing maintenance and repairs of oil enclosed vs. open train meters, of all ages in the two groups, Mr. Trentlage reported costs of repairs for the open train types at $5.56 as against $1.72 per unit for the enclosed train type. As to the sensitiveness and accuracy of the two types after 300,000 cubic feet registration the open train units were dead at ¼ g.m.p. whereas the oil enclosed train units averaged

E. L. Gaudin
Mathieson Alkali, Cincinnati

Carl Bridges
Supt. Water, Jamestown, Ind.

Ralph Hoot
Ch. Chemist, Ft. Wayne

89 per cent in registration. The same type after 100,000 cubic feet of service registered 100 per cent accurate, as against 37 per cent for the open train units of same service registration.

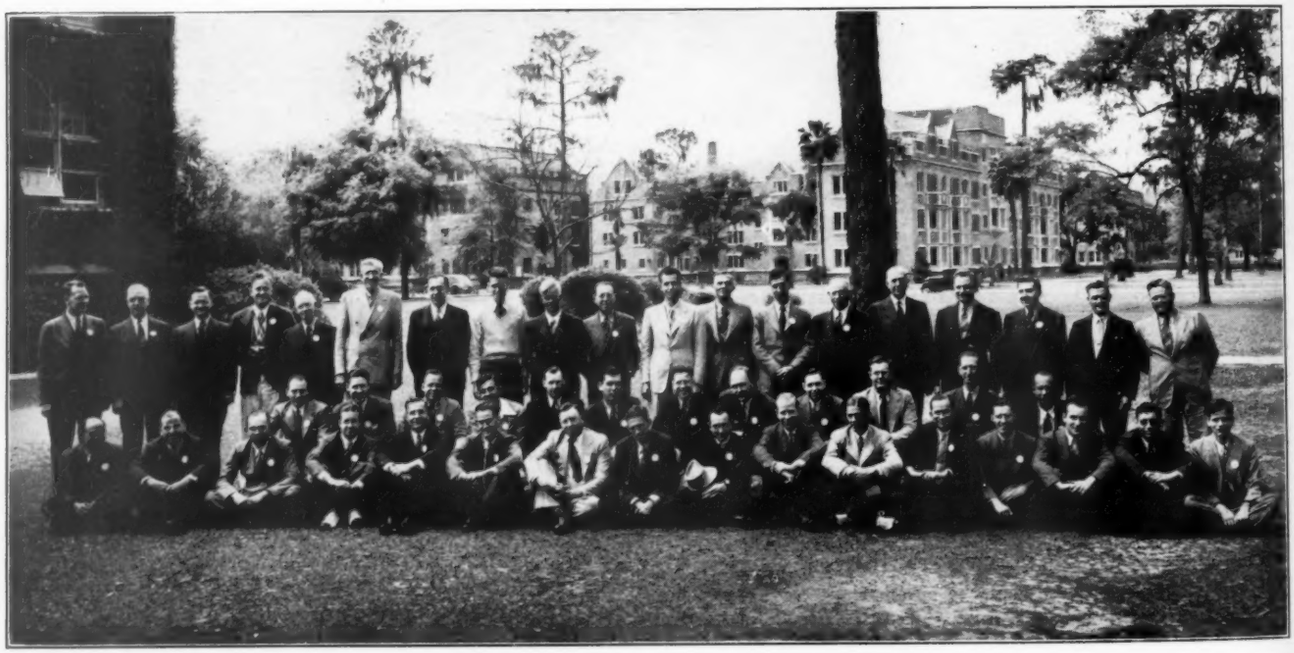
Meters proving 3 per cent high (ie.—103 per cent) at low flows did not run high through the 12 g.p.m. tests.

Water Company Color Film Shown

The meeting closed with the showing of the technicolor film *"The Waterway to Health,"* made for, and exhibited by, the Indianapolis Water Company to the public of Indianapolis, as a public-relations feature—both entertaining and educational. This is the second such movie used to good advantage by the company, who believes in showing consumers "what's behind the water spigot"—and perhaps in encouraging extended use of water for various purposes. This very fine film was shown by J. E. Kleinhenz.

Howard Luncheon Speaker

At luncheon the closing day President Norman J. Howard, as principal speaker, reviewed Canadian experiences with defense measures adopted for safeguarding water works. Such have been outlined at several meetings by Mr. Howard and reported in previous issues. He did emphasize the value of flood lighting and fencing, with patrols employed at the more vulnerable points; the advisability of examination and scrutinization of employees, thereafter supplied identification cards. He also stressed neighbor city cooperation looking to mutual preparedness and exchange of assistance in the form of equipment and personnel. There had been no evidence of serious attempts at plant damage in Canada and but little abroad; neither had there been evidence of attempts at water poisoning or bacterial contamination. However, chlorination of all water leaving distribution reservoirs seemed a precaution not difficult and an added measure of safety at little expense.



Those Attending the 9th Annual Short Course for Water and Sewage Works Operators University of Florida—April 2-5, 1941

Held under joint sponsorship of the Extension Div. of the University, the State Dept. of Health and the Florida Section of A.W.W.A. At this school the Florida Water Works Operators Association was formed, with Keith R. Chinn of W. Palm Beach as President; R. M. Johnson, of Tampa as President-Elect; and R. D. Carnahan of Bradenton as Secy.-Treas.

WILL TORONTO CONVENTION OUTSTRIP KANSAS CITY?

UNTIL recently a few had any serious thoughts that the 1941 A.W.W.A. Convention, scheduled to be held in Toronto June 22-26th, could be expected to outstrip the record making 1940 Convention held in Kansas City. However, with Secretary Jordan reporting early this month that 1200 reservations have been made for hotel accommodations, in as many individual names, this index seems sufficient reason to hazard a prediction that the Toronto Convention will in all probability go Kansas City one better in attendance.

In this regard it is not to be forgotten, either, that the Canadians are doing their share to make of it a new record in A.W.W.A. Conventions, remembering that the Toronto Convention of 1929 for many years remained the record A.W.W.A. Convention.

Toronto's Location Interesting

Aside from the excellence of hotel facilities for a convention, possibly one reason why Toronto is such a well attended convention city is its location with respect to distances from important cities in the United States. This fact was rather impressed on this writer by the accompanying sketch, showing the relative locations of many important cities with respect to travel distances to Toronto. For example, Toronto is as easily and as inexpensively reached from Richmond, Va., as from Boston, Mass., both being but a shade over 400 miles distant. Indianapolis and Chicago are only 430 miles away and Cincinnati less than 400. New York City, Baltimore, and Washington are practically equally distant—less than 350 miles.

The impressive part of all this is that if the reader will examine this map he will be impressed, not with how far he is from Toronto—but *how close* he is to the 1941 Convention City.

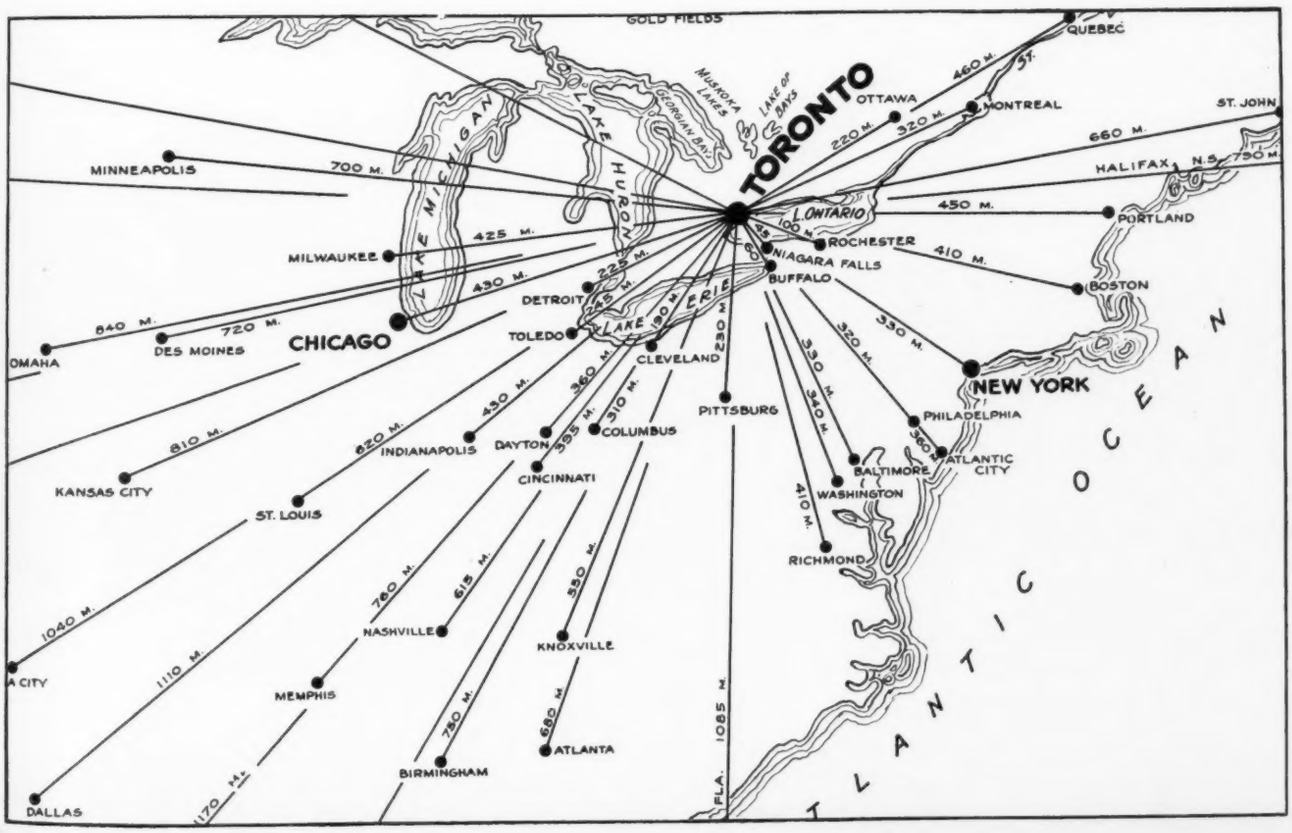
What Is Involved in Going Into Canada?

Some time ago A.W.W.A.'s headquarters office propounded a series of questions to the Canadian and American Customs and Immigration Authorities in order to give to all members of the association the true facts concerning procedure in entering Canada; what to expect in Canada relative to war rules and regulations; and, what to expect in re-entering the United States. These questions and answers may contain some that have been in the minds of our readers and, therefore, are here reproduced.

1. What is the detailed procedure when an American citizen enters Canada by train and are any identification papers required by such a person in entering Canada?

When an American citizens enters Canada by train, the Customs Officer will simply ask him if he is bringing in any material other than personal effects. No identification or papers are required. The Canadian Immigration Officer will ask what country he is a citizen of; if American citizen by naturalization, he should carry his naturalization papers with him, or a certificate proving that he has been naturalized. No papers required if the visitor is United States born. The Canadian Immigration and Customs Officers at border points will be notified that the A.W.W.A. convention is being held June 22-26, 1941.

2. What is the detailed procedure when an American citizen enters Can-



ada by automobile and what papers are required in connection therewith?

American citizens entering Canada by automobile will without trouble or delay be issued a permit at the border. There is no charge for this permit, and it will be good for 30 days or 6 months—whichever the visitor asks for. The driver of the car will be required to produce his car ownership license card, and his operator's license if his home state issues such a license. Passengers in the car will not be required to produce any papers, with the exception of naturalized citizens, who should be prepared to produce proof as above.

3. Is there any time limit on the period that one may stay in Canada, including one's car, if one is traveling by automobile?

The time limit for an automobile Customs' permit is 6 months.

4. In returning to the United States what, if anything, do the Canadian Customs or Immigration officials require in reference to currency or exchange taken out?

United Sates visitors returning to the United States are not so questioned by the Canadian Customs or Immigration Officials.

5. What form of identification will be acceptable to the United States Customs officials for an American citizen returning from Canada?

United States citizens who are born in the United States will be required to identify themselves to the satisfaction of the United States Immigration Officials. An automobile operator's permit, a voter's card, service club membership card, or personal papers have been accepted as satisfactory. Naturalized citizens should have their naturalization papers, or a certificate to that effect. U. S. citizens are not subject to United States Immigration laws.

6. Are the United States officials interested in either the amount or character of funds in the possession of the returning U. S. citizens?

Not at all.

7. What is the value of Canadian goods purchased that may be brought into the United States free of duty by each person?

Each American citizen may purchase in Canada merchandise to the extent of $100.00, and declare this duty free at the border—husband and wife $200 in value, but nothing is allowed for children or minors.

8. Does it make any difference, if one is traveling by automobile (or train) if the Customs point of return to the United States is different from the point at which entry to Canada was made?

There is nothing to prevent a United States citizen entering Canada at one point and leaving at another.

9. Is there any restriction on taking cameras into Canada and/or bringing back cameras or exposed but undeveloped films from Canada to the United States? If so, what are the restrictions and what restrictions, if any, apply to taking pictures of any part of Toronto?

There is no war time restriction on United States visitors bringing cameras into Canada. It is possible that the Canadian Customs Officer will require them to register the camera at the border, so as to make sure the camera is taken back to the United States with the visitor; this is not a war time regulation. There is no restriction on a United States visitor taking his camera and undeveloped films back to the United States.

10. While in Canada, what are the war-time requirements, if any, that are to be observed by American citizens?

American citizens are not required to observe any war-time regulations.

11. If an American carries an express check or letters of credit, payable in Canadian currency, what is the usual charge, if any, for cashing such checks?

Letters of credit and American Express travelers' cheques are subject to a Canadian 3c stamp on any cheque up to $100.00; and a 6c Canadian stamp for anything over that.

12. It is understood that the fixed rate of exchange between American currency and Canadian currency is a ten per cent discount on Canadian currency. Is this the fixed differential that is allowed at hotels, in stores and in banks in Toronto?

The Foreign Exchange Control Board of Canada has fixed a rate of 10 per cent premium on American currency, and it is illegal for any person in Canada to accept American currency without allowing the 10 per cent premium in purchases or in receiving change.

Toronto Papers and Speakers

The technical program, which follows, gives evidence of the fact that A.W.W.A.'s technical committees are going ahead in good order.

It will be noted that defense measures are in a way the key topics, and it is expected that hitherto unrelated experiences in water supply experiences and practices abroad, developed under conditions of enemy attack, will be revealed for the first time by a speaker at the Toronto Convention.

Colonel Willard Chevalier will be the featured speaker on Tuesday night to point out some observations and discuss considerations of trends in "The World of Today and Tomorrow?"—not alone in regard to public utilities, but in general. It will be well worth listening to.

The Technical Program

(Monday, June 23)

Forenoon—General Session

The Defense of Water Supply Works in Wartime, Norman J. Howard.
Emergency Radio Communication, Wm. Victor Weir.
Chlorination Equipment Available for Emergency Use, Harry A. Faber.
Experiences in the Use of Emergency Chlorination Equipment, Gerald E. Arnold.

Afternoon—General Session

State Wide Plans for Water Supply Defense, H. T. Critchlow.
Regional Water Supplies, Abel Wolman.
Factors in the Control of Reservoir Silting, Carl B. Brown.
Manufacturers' Symposium—Equipment Available for Emergency Repairs to Distribution Systems, Clinton Inglee, H. Y. Carson, Rossiter Scott, J. C. Gorman, Nelson Thompson.

Afternoon—Steel Pipe Committee

Current Activities of the Steel Pipe Committee, W. W. Hurlbut.
Mechanical Application of Bituminous Pipe Coatings and Linings, L. E. Goit.
The Stone Canyon Pipe Line of Los Angeles, A Moving Picture.
Standardization of Steel Pipe Flanges, Russel Barnard.

(Tuesday, June 24th)

Forenoon—General Session on Finance and Accounting

Water Rate Structures in Canada, Domestic Rates, A. E. Berry.
Municipal Services and Fire Protection, Wm. Storrie.
Financing and Accounting Methods in Use at Denver, Geo. F. Hughes.
Management Problems in a Municipal Utility District, J. S. Longwell.
Experiences with Federal Housing Developments, Hal F. Smith.

Forenoon—Water Purification Division

Studies in Corrosion Control, H. P. Stockwell.
Scientific Control and Critical Appraisal of Experimental Work, J. F. Norton.
Viability and Destruction of the Cysts of Amoebic Dysentery, S. L. Chang and G. M. Fair.
Some Applications of a New Method of Determining Residual Chlorine, H. T. Marks and J. R. Glass.

Afternoon—Water Purification Division

Investigating the Quality of Water in a City Distribution System, W. M. Wallace.
Revising the U. S. Standards for Drinking Water Quality —A Symposium, J. K. Hoskins, C. R. Cox, G. D. Norcom, J. R. Baylis, Abel Wolman.

Afternoon—General Session

Experiences with Cathodic Protection of Water Tanks, J. Clark Keith.
Experimental Studies of Tank Coating Materials, J. O. Jackson.
Applications of Cement Lining to Water Lines, Experience at Akron, Wendell R. LaDue; Experience at Toledo, George Schoonmaker; Experience at Cincinnati, Carl Eberling.
A Program of Research Upon the Effects of Electric Grounding on Water Pipes, Rolf Eliasson.

(Wednesday, June 25)

Forenoon—Finance and Accounting Division

Progress in Security and Retirement Planning for Utility Personnel, Dale Maffitt.
Value of Civil Service to Municipal Water Plant Operation, John B. Probst.
The Limitations of Civil Service, H. A. Van Norman.
Discussion, E. V. Buchanan.
Public Relations Begin at Home, or A. B. V. R. Goldfish, John C. Mellett.
Report of Committee on Joint Administration and Collection of Water and Sewer Accounts, L. N. Thompson.
Discussion, J. A. Hickey, Hal F. Smith.

Forenoon—Water Purification Division

(Committee Reports)

Activated Carbon Research, M. M. Braidech.
Specifications for and Methods of Testing Zeolites, D. E. Davis.
Methods of Determining Fluorides, A. P. Black.
Chloramination, F. W. Gilcreas.
Standards for Purification Plant Operation, Edw. S. Hopkins.
Water Conditioning Methods to Inhibit Corrosion, Edw. W. Moore.
Specifications for Filtering Material, Paul Hansen.
Methods of Water Treatment and Laboratory Control, George D. Norcom.

(Thursday, June 26)

Forenoon—General Session on Distribution System Safety

Cross-Connection Control—A Committee Report, E. S. Chase, Ch.
The Pollution and Emergency Disinfection of Rochester's Water Supply, Earl Devendorf.
A Manual of Safe Practice in Water Distribution—A Committee Report, Wm. E. Stanley, Chairman.
Progress in Plumbing Standardization, M. Warren Cowles.

Forenoon—Plant Management and Operation Division

A Survey of Water Main Extension Policies, L. A. Jackson.
Development of Houston's Water Supply, G. L. Fugate.
Discussion, L. R. Howson.
Protection of Buffalo's Pumping Station Against Service Interruptions, L. A. Bergman.
The Control of Automotive Equipment, L. A. Geupel.

Afternoon—Plant Management and Finance Division

(Joint Session)

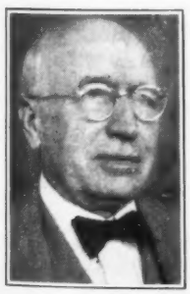
Relation of Meter Rates to Distribution System Conditions, C. H. Capen, Jr.
Meter Reading and Commercial Department Operation, K. K. King.
Cost of Meter Repairs, A. P. Kuranz.
Report of Committee on Meter Specifications, S. F. Newkirk, Jr.
Special Rates and Free Water Service, Dale Maffitt.
Discussion led by Ross Dobbin.

Papers to be Presented by Title Only

Toronto's New Purification Plant and Pumping Station, A. U. Sanderson and L. F. Allen.
Some Problems in the Design of a Pumping Station, Eduardo Molina.
Six Centuries of Water Supply in Mexico City, Alfonso Villa-Acosta.

Past President of A.W.W.A. Twice Honored

Receives Honorary Degree from Alma Mater



J. E. Gibson (SeD.)

James E. Gibson, Chief Engineer and General Manager of the Charleston, S. C., Water Works Commission, was during the recent convention of the Southeastern Section of A.W.W.A. in Charleston, honored in his own home town by being voted the Geo. W. Fuller Award for engineering acumen and his contributions to present day water works practice, and his leadership in the Section and the National Association of which he is a Past-President, an Honorary Member, and a Diven Medalist.

On the heels of this recognition it was also announced that Mr. Gibson will in June receive other honors of distinction. Next month his Alma Mater, the University of Arkansas, will confer on him the honorary degree of Doctor of Science.

The above advice had been received from President Fulbright of the University of Arkansas, only a short time prior to the Charleston meeting. Many southeasterners were elated, too, to learn that "Doc" Gibson (soon to be) is a native of the "Slow Train" State and not a "Dam Yankee" after all.

ILLINOIS SECTION

Stages 33rd Annual Meeting in Quincy April 28-30th

CONSIDERING the extreme southeastern location of Quincy, with respect to the territory served by the Illinois Section of A.W.W.A., the registered attendance of 150 at its recent annual meeting proved encouraging to those who have been putting new life into this long established Section, which has such a high potential in membership and meetings attendance.

Chairmen

(Retiring)
George B. Prindle
Supt., Water Wks.
Highland Park

(Incoming)
H. H. Gerstein
Div. of Purification
Chicago

The filter plant of Quincy, on the Mississippi, was one of the earliest of the rapid type plants in America. It was here that one George Bull developed the iron-lime method of coagulation, the source of the coagulant being scrap iron and sulphuric acid or chlorine. However, the price of chlorine at that time made its use prohibitive. Considerably later much was heard of the so-called "Bull Pot," which the courts declared an infringement on the Ornstein chlorination patents, because of its use in chlorination and not for coagulation.

At the Quincy plant, visited on the closing day, was seen the most modern method of recarbonation—namely direct absorption of CO_2 gas produced by under water gas burning, first applied at Oklahoma City and described by L. H. Scott and F. C. Abbott in the October 1939 issue of WATER WORKS AND SEWERAGE. This development won for Mr. Scott, Sup't. of Filtration at Oklahoma City, the George W. Fuller Award from the Southwest Section for 1939.

Following the filter plant inspection, the Quincy plants of the Gardner-Denver Co., makers of water and sewage pumps and air compressors, and the Dayton-Dowd Pump Co. plant were visited.

Entertainment

To use the highlight of the entertainment was the "Fellowship Hour," staged on the second afternoon. We would name it the "Conviviality Hour" as a more exact description of what it actually was —(see Figs. X. Y, Z, etc.). Following thereon came the Annual Dinner, at which it was hard to tell who the toastmaster was—the "convivialized" Chairman George Prindle or droll Paul Hanson, the latter being the official master of funpoking, who did a splendid job. After all this, came the imported St. Louis floor-show which cost manufacturers' representatives something more than the regular registration fee.

Program Highlights

The high-light of the technical sessions were two papers of the "We'll tell you, if you'll tell us" variety. The first was that titled **"What the Salesman Can Offer a Water Works Operator"** — by a salesman who should make his living pulling laughs on the lecture platform if he ever gets out of a job selling water works equipment. The second was the voice from a serious minded young operator, who revealed **"What an Operator Expects from the Water Works Salesman."** It is doubtful that these two papers will read as well as they "listened" when presented, but they will prove interesting and entertaining—so watch for both.

Honored
Frank Amsbary, Jr.
Champaign
National Director
(Vot. Fuller Awd.)

Elected
Fred W. Hartmann
Chicago
National Meter Div.
(New Vice-Chm.)

The other highlight was the heart-to-heart exchange between operators and designing engineers on **"Items in Plant Design Which Should be Considered from the Operator's Standpoint."** Then the reply of engineers "before the bar," explaining why everything the operator may expect can't always be supplied.

Two Important Bills Endorsed

Amongst resolutions passed were those endorsing two bills of importance now before the State Senate.

Senate Bill 396, if passed, will Create a Water Works Operators' Examining Board, to classify and establish the fitness of water works operators in Illinois.

The second Bill is apparently an outgrowth of the Manteno State Hospital typhoid outbreak in which it was surprisingly shown how limited were the actual powers of the State Department of Health, in respect to enforcement of regulations and orders pertaining to water supply. Senate Bill 397 is titled "An Act to Control Installation, Operation and Maintenance of Public Water Supply Works in Illinois."

Sec'y-Treas.
H. E. Hudson, Jr.
Chicago
Water Pur. Div.
(Doing a good job)

Chief
C. W. Klassen
Springfield
State San. Engr.
(A remarkable review, his)

An Act of 1939, also endorsed, is that regulating well drilling by requiring drillers to secure permits; also that drill cuttings, when desired, be supplied the State Authority. A resolution passed recommended that this Act be placed under the State Department of Health instead of the Department of Mines and Minerals, where it now resides with only partial enforcement.

Fuller Award to Amsbary

To Frank Amsbary, Jr., Manager and Supt. of the Illinois Water Service Co. at Champaign, was voted the coveted Fuller Award for 1941.

In making the announcement at the Annual Dinner, L. R. Howson, President Elect of A.W.W.A., stated that in addition to the fact that Frank, Jr., was born and raised a good water works man, by his venerable "dad" who preceded him, he had proved a civic leader and all-round citizen in his community. In

consequence, the award is "In recognition of his valuable contributions to his profession, to A.W. W.A., and to his community." So reads the citation.

(The Amsbary case is something of a reminder that in Illinois there seem to be a number of cases in which fathers raise their boys to be water works men. At Quincy, W. R. Gelston, Jr. has within the year stepped into the shoes of his appreciated father, whose life was snuffed out in an automobile accident. Then there is the Trentlage father and son combination at Elgin. And, M. M. Symons' boy "Doc" George left the Danville water works to become Chief Chemist of the Buffalo, N. Y. Sewage Works, where he now deals with the used water supply of that city for the benefit of other water supplies.—Ed.)

Officers Named

Officers for the next year are:

Chairman

H. H. Gerstein, San. Eng'r., Water Purification Division Chicago

Vice-Chairman

Fred W. Hartmann, Dist'r. Mg'r., National Meter Division Chicago

Sec'y-Treas.

Herbert E. Hudson, Jr. San. Eng'r., Water Purification Division Chicago

Trustees

Clifford Fore, Sup't. Filtr., Carbondale.

H. L. White, San. Eng'r., Urbana.

(Serving as National Director is Frank W. Amsbary, Jr.)

Technical Sessions

Chairman, George Prindle, Highland Park, Presiding

(We regret the necessity of limiting the length of this report but inflexible space limitations dictate that those topics having the least general interest will have to be dealt with very briefly.—Ed.)

"Obtaining the Correct B-Coli Index," by Ralph E. Noble, Principal Bacteriologist, Board of Health, Chicago.

Mr. Noble reported on a series of studies of the B-Coli Index determination, evaluating the worth of samples of various sizes, in seeking a more dependable Index No. with the present standard method. In brief his work indicated no gain in the use of 50 cc. or 100 cc. portions, unless it be reduced laboratory work to plant the larger portions than the 5-10 cc. tubes. In fact a higher index resulted from the 10 cc. tubes for equal total volumes tested in the 10 cc., the 50 cc. and 100 cc. fermentations.

Edw. E. Alt, Sales Engr. Chicago Bridge & Iron Co.

W. R. Gelston, Jr. Supt. ofWater Works Quincy, Ill.

L. A. Nalefski Chemist, Water Dept. Decatur, Ill.

An interesting revelation was the fact that in the 1 cc. portion test (and all lesser amounts), the most correct Coli Index resulted from those series in which 50% of the tubes showed positive and 50% negative.

Others present revealed that experience elsewhere had indicated no advantage from testing 100 cc. portions as against 5-10 cc. portions.

M. M. Symons, Chief Engr. Interstate Water Co., Danville (46 years of continuous service)

G. F. Stoldt, Supt. Water Dept., Jacksonville, Ill. (Prize-winning gadgeteer)

John R. Baylis, Physical Chemist Bureau of Engineering, Chicago (His surface wash started something)

"Military Field Water Supplies" —by Thomas T. Quigley, Sales Engr., W. & T. Co., Chicago.

Mr. Quigley was prevented from attending. His paper, read by Mr. Abplanalp, an associate, briefly reviewed procedure in field water supply practice in the U. S. Army, and described Wallace and Tiernan contributions of the speedy 1941 model 2½ ton water purification truck—a complete unit for coagulation, filtration and sterilization, capable of 45 m.p.h. speeds and purification of 100 g.p.m. at filtration rates of 10 gal./sq. ft./min.

For combat forces a smaller two unit outfit is supplied, weighing 450 lbs. Through its 17 inch pressure filter is capable of turning out 50 gal./min. at the (10 g.p.m./sq. ft./rate) to give a safe chlorinated water of 10 or under turbidity. Back washing of both types must be done with unfiltered water when clear water is not stored. Each combat Engineering Division is supplied four of the smaller outfits, each regiment one of the larger.

"Protection of Water Works Structures" by Horace R. Frye, Ass't. Sup't., Water Department, Evanston, Ill.

In Mr. Frye's absence his paper was read by Mr. Amsbary. It told of the Evanston practice, since 1937, of having one man charged with the inspection of structures and recommendation of the protection work needed. A paint crew has been established for some time, and besides water works jobs painting for other city departments is done at actual cost.

Citing experiences with 3 elevated tanks, the cost for repainting at five year intervals had been $75 per yr./per tank. To paint the 1 m.g. tank cost $658—the application on interior being 3 red lead coats and one of aluminum. Submerged surface test panels had indicated no protective painting tested proved good for more than 2 years without requiring attention.

Since July 1939 the larger tank had been protected with the cathodic system, involving 5 graphite electrodes and a copper-oxide rectifier. Breakage of electrodes, due to ice, had been the chief problem. As a result the more recent electrodeless system was being tried, consisting of little boxes attached to the exterior tank walls in place of electrodes. For past 3 months current at 5.6 amps. and 17 volts indicated the electrodeless system more expensive to operators than that with electrodes. Inspection had indicated satisfactory protection, however. Mr. Frye closed with the following suggestions: (1) Annual inspection, repair and repainting programs. (2) Operate such program with city labor. (3) Choose coatings only on basis of proven endurance under similar conditions. (4) Do not overlook cathodic protection as an economy measure having considerable promise of a number of advantages.

Mr. Amsbary, with one tank cathodic equipped at Champaign, has well water. To preclude freezing, the winter routine is a replacement daily of 33 per cent of tank volume by letting the tank level drop that much before each refilling.

Hospitality Hour

(Second from left)—Serenading president "N. J. H."; (second from right)—Alt, Lingnor, Brune, Tolburg et al. serenading the serenaders, when Hospitality Hour Chairman Dallach, suspecting something, whirls around just as the camera clicks; (extreme right) the secretary's comely better half, Mrs. "Herb" Hudson of Chicago, is the attraction in this picture.

"Unique Experience With Chlorine" by George B. Prindle, Sup't. of Water, Highland Park, Ill.

Mr. Prindle to add "umph" to the program (as he said) unraveled his story of "The Mystery of a Dirty Pool." The case was the pool of elite Highland Park, where 0.5 p.p.m. residual chlorine as chloramine was maintained. The chlorine entered ahead of the pressure filters, as did the alum from the always questionable alum pot. An occasional bad sample report came back from the State, and broth culture tubes in his (Prindle's) laboratory had vile odor. Why chlorinate ahead of the filter was the question coming to his mind. The chlorine feed (no more —no less) was changed to the filter effluent. With it disappeared the bad sample experience and likewise the vile culture-tube odors. And thus the question remained—"Why chlorinate ahead of the filters rather than beyond?"

Another question raised was why use thiosulphate in samples collected and shipped uniced to the State Laboratories? Others also questioned the excess thiosulphate method of removing the chlorine effect, in contrast with neutralization with broth culture media instead. Samples of thiosulphate treated waters (pool and drinking) seemed to give unexplained high counts frequently.

Others present had switched chlorine application from effluent to influent, without noting any difference in pool results.

Linn Enslow remarked that his experience with pools would indicate that, with ammonia used, a residual of 0.5 parts chlorine could not be considered the equal of 0.5 parts without ammonia (either contributed by bathers or added). When the 0.5 residual was set as a pool requirement by the Committee of the State Sanitary Engineers Conference, ammonia had not been considered. With ammonia, and particularly at times of boosting the alkalinity (pH) of pool water, the rate of kill slowed appreciably and sample neutralization or pool side planting would reveal such. With ammonia about twice the residual should be carried as without, and could be without complaint.

"What a Salesman Can Offer a Water Works Operator" by Edward E. Alt, Sales Engr., Chicago Bridge & Iron Co., Chicago.

Mr. Alt said that he had accepted the Program Committee's invitation with zest, but now the hour had come when he could see the point of a certain woman in a maternity hospital, when she said, "Isn't it exasperating that something which is so delightfully easy to conceive should be so hard to deliver." With that ice-breaker, the first barrier of sales resistance of Alt's audience was down—and, he went to work.

"Just a Settin' in the Sun"

(Left)—"Doc" Buswell and Winnetka's chemist, Olson; (center)—Permutit's W. H. Mitchell, Chicago, and John C. Tracy, St. Louis; (right)—O. B. Carlisle, Chicago's Engr. Water Works Design, and "Mike" Foley, Hersey Meter Co.'s Chicago manager.

Salesman to Operator and Operator to Salesman

Now we come to the highlight of the program already referred to, in which the salesman and the operator were expected to do some "hair-taking down" and come out in the open with everything—no holds barred. And they did—too. We think, however, that the operators took some advantage of the salesmen by putting their "champion" up to be shot at first. However, their spokesman was equal to the job and interspersed laughs throughout the more serious part of the presentation. So hear ye!

Getting into the meat of his paper, Mr. Alt pointed out that one of the first pre-requisites of a water works salesman is that he be technically grounded and accurate. He can and should serve as a trouble-shooter—particularly in following up operations and performance of the equipment he sells. He can and should serve as "ambassador" in settling difficulties that may arise between the operator and the salesman's principals.

The salesman, really interested in his job and the operator he calls on, serves as a medium in exchange of information. He passes along methods found to be helpful in

During the Floor Show and Conviviality Hour

(1) Entertainment Chairman "Jeff" Abplnap wondering what if the magician should get mixed up in this decapitation trick; (2) Woltman, Consulting Engr. of Bloomington, and Lou Birdsall; (4) and "Prof." Babbitt (Univ. Ill) has "just swallowed the mouse." Baylis didn't realize it, but the wily "Prof" pulled a fast one on John by handing him the tall glass when he saw what was coming. (5) A clever young adagio dance team—"tops" in fact.

Over 700

SUCCESSFUL COMMINUTOR INSTALLATIONS SPECIFIED BY 200 CONSULTING ENGINEERS

COMMINUTION:—Subsurface, automatic screening and cutting of coarse solids without removal from sewage channel.

No screenings odor or fly nuisance.

No manual labor for collecting and disposal of screenings.

No clogging of mechanical equipment by coarse sewage solids.

No additional scum formation or floating solids.

Comminution is automatic and trouble free, requiring manual attention only for lubrication, periodic inspection and simple sharpening of cutters.

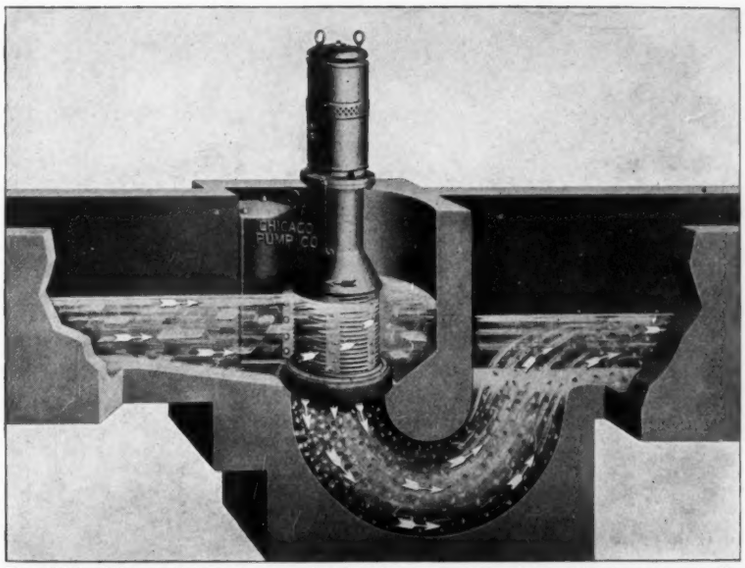


Fig. 2202—"Chicago" Comminutor, showing how coarse sewage matter is automatically screened and cut into small pieces that subsequently settle out in primary tank and prevent clogging of mechanical equipment.

Trouble-free, Automatic Subsurface Cutting of Coarse Sewage Solids Insured By Hydraulic and Mechanical Design of Comminution Structure

1. **BASIN:** Standard hydraulic design of Comminutor basin accomplishes—

   (1) Uniform distribution of sewage solids on the entire submerged surface of the slotted Comminutor drum.

   (2) Causes all rags and solids to be caught and cut, recaught and cut by cutters into sizes that will pass through the ¼" to ⅜" drum slots.

   (3) Washes large grit particles from rags, thus reducing wear on cutters.

2. **SELF-CLEANING SCREEN:** Revolving slotted drum and stationary cutting and scraper bar provide a positive self-cleaning, cutting screen for all material over ¼" to ⅜" in size.

3. **CUTTERS:** Design of cutting members provide—

   (1) High cutting rate by cutters and cutting bars on the revolving drum and slotted stationary cutting bar.

   (2) Rejection of stones and metal to prevent damage to the cutters.

   (3) Simple removal and sharpening of cutting members.

   Shearing stresses and power requirements are minimized by the distribution of the cutting action over the entire revolution of the drum.

4. **MATERIALS:** Selected for their proven resistance to corrosion and abrasion.

COMPLETE DIMENSIONED LAYOUTS AND SEWER FLOW CURVES IN BULLETIN 185-A

CHICAGO PUMP CO. SEWAGE EQUIPMENT DIVISION

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VACUUM—CONDENSATION—CIRCULATING—BILGE
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AERATORS—COMMINUTORS—SAMPLERS

REPRESENTATIVES THROUGHOUT THE UNITED STATES AND FOREIGN COUNTRIES

This cast iron water main laid at Ft. Jackson, S. C., in 1917.

—was recently lowered under pressure after 23 years' service.

—with an offset in the line of about 15 feet.

Note cast mark (1917). Pipe was laid during World War I.

"This group of photographs illustrates the lowering of a 16-inch cast iron water main at Fort Jackson, South Carolina, in connection with the present National Defense program. This line was originally laid in 1917, during the last world war, as shown by cast marks (see lower right). The line was lowered under pressure and after 23 years of service, no leaks were found and the pipe was naturally in perfect condition. There is an offset in this line of about 15 feet, yet nothing but straight pipe was used." (The foregoing is a simple transcription of the statement submitted by the contributor of the photographs.)

Note for Water Works Men: ***The original use of cast iron pipe made this money-saving operation possible***

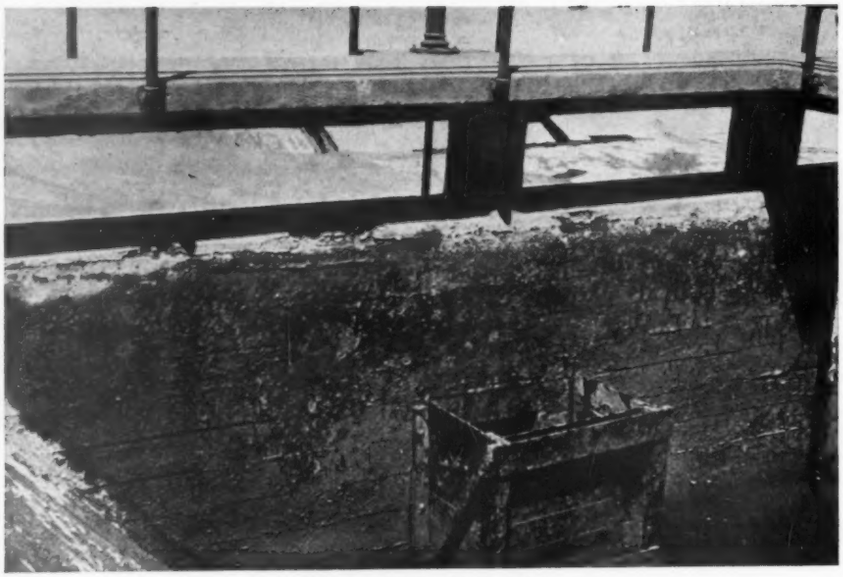
Look for the "Q-Check" registered trade mark. Cast iron pipe is available in sizes from 1¼ to 84 inches.

BLACK OUT ALGAE

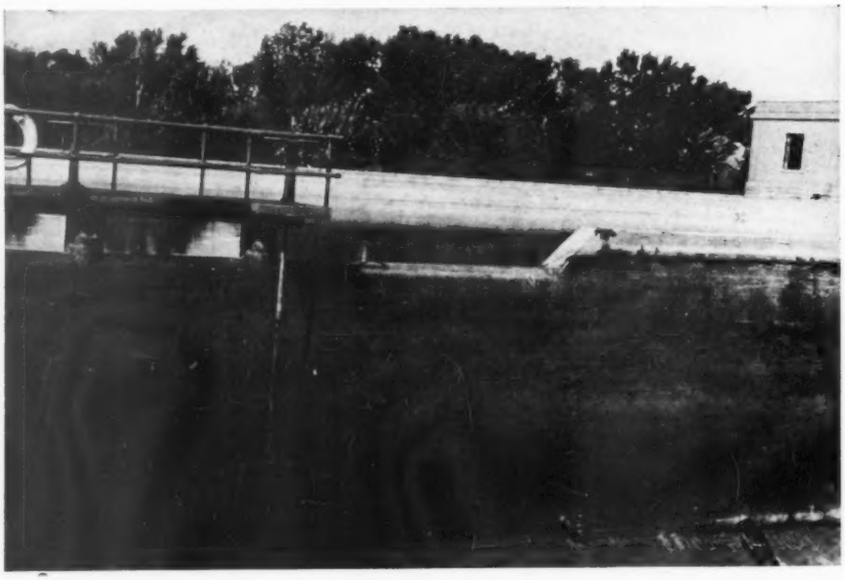
WITH

NUCHAR — INSURES PALATABLE DRINKING WATER

ACTIVE CARBON



BEFORE THE BLACK OUT
This is a view of the weir wall when the basins were emptied for washing in May, 1939, despite applications of copper sulphate.



AFTER THE BLACK OUT
This is a view of the same weir as in picture above when the basins were emptied for washing in October, 1939. Note the effectiveness of the Black Out treatment as shown by the absence of algae.

The superior ability of AQUA NUCHAR Active Carbon to remain in suspension in water for a long period of time prevents penetration of sunlight to any great depth in the sedimentation basin. Since sunlight is one of the essentials for algae growth, this important characteristic of AQUA NUCHAR prohibits the propagation and growth of algae by "blacking out" light penetration.

See your March, 1941, issue of "Taste and Odor Control Journal" on "Blacking Out Algae". If you have not received your March, 1941, issue, write to our nearest office for one today.

61st ANNUAL MEETING AWWA JUNE 22-26 1941 ROYAL YORK HOTEL TORONTO CANADA

INDUSTRIAL CHEMICAL SALES

DIVISION WEST VIRGINIA PULP & PAPER COMPANY

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844 LEADER BLDG., CLEVELAND, OHIO

(1) C. R. Miller, Supt. of Water & Elec., Winnetka, and G. H. Ruston, Supt. of Water, Kennilworth, Ill.; (2) S. T. Anderson, Adm. Assistant, Springfield Water Dept., and Alex. Van Praag, Consulting Engr., Decatur, Ill.; (3) N. J. Howard, President, A.W.W.A., and George Prindle, Chairman of the Section; (4) W. A. Dallach, Sales Engr., Crane Co., Chicago, and O. T. Birkness, W. & T.'s Distr. Mgr., Chicago; (5) Geo. White, Mueller Co., Decatur, Ill., and L. J. Lindberg, Clow-National Co., Chicago.

solving problems elsewhere. He talks to many operators, sees many operations and field and plant practices, attends many meetings. If his eyes and ears are open, and if he takes a real interest in the field he is serving, he will pick up more information in a few months than the average operator can obtain on one job in several years. The helpful salesman will learn of good things and pass them along. Thus he may save the operator's company or city a good many dollars, and hopes to be instrumental in bringing credit to the operator.

Then there is the social side of the picture wherein a salesman may make many staunch personal friends of those to whom he may also sell goods. The operator need not and should not feel that a salesman is attempting to "buy his way into an order" when inviting the operator to a ball game, dinner or luncheon; for this is frequently the beginning of some fine and staunch friendships which come as the most cherished and pleasant part of the selling game.

For all, that a salesman may have to offer, he asks but little in return—the first being fair-play. And, fair-play means that the salesman be dealt with frankly and told the truth, rather than being misled or kept dangling while he spends his company's time and money (hopefully) only because he cannot see what is behind the scenes. In brief, all that the salesman asks is, a courteous interview and a regard for the "Golden Rule"—again, fair-play.

"What an Operator Expects from a Water Works Salesman" by L. A. Nalefski, Chemist, Water Department, Decatur, Ill.

Mr. Nalefski's paper was, he explained, built around many replies received in a miniature Gallup poll of operators. As the context revealed, the paper might have more descriptively be captioned "What the operator should not expect of the salesman." In any event it contained some very frank and constructive opinions as well as many "pet peeves" of some. Here they are!

First—Integrity of the salesman was the prime requisite. In short, there should be no attempt to mislead, directly or by inference; so-called "white lies" being included. Knocking the competitor's equipment merely invited more attention to it—therefore no gain. The salesman should always recall that the day of *"caveat emptor"* has passed.

Second—Know your product, is primary advice to all salesmen. Writing to the home office for the answers is not interesting, nor is it strengthening to the representative. He should not attempt to substitute something or place materials or equipment where there is any gamble as to its suitability or ability to perform properly—that is, unless the installation be arranged purely on an experimental or trial basis. In other words, the salesman should know what and where not to sell, as well as where and what to sell, if his standing and his company's reputation is to go forward and not backward. In the sale of processes and chemicals the mystery and secret information aspect should not be emphasized. On the contrary, all patented phases should be clearly revealed. without being used as a pressure measure.

Third—Intended more for the company than the salesman, was the general criticism of present day bulletins and catalogs which operators considered nice stream-lined "picture books," but for the most part lacking in worthwhile technical information and specifications from which the prospective buyer might make comparisons or learn what he is expected to buy. A word from salesmen back to headquarters concerning this failure of a valuable selling aid might improve this side of selling.

(In this last matter both operators and salesmen may be interested to know that the Association of Business Paper (A.B.P.) has for the past 18th months been making a strenuous effort to persuade manufacturers in the technical field, such as the utility field is, to employ what has been termed the "Tell-All" type of copy in their advertising and trade literature. Amongst publishers there is a general feeling that readers have been "stream-lined" to death, and find that the real information needed is hard to get in printed form. The movement is having some good effects on those who can boast quality products as well as color and stream-lining.—Ed.)

Amongst the so-called "pet-peeves" of operators Mr. Nalefski listed the following: (1) The salesman who overstays his welcome, wants to learn much and return little. (2) The salesman who fails to come to the correct person, or he who by-passes the operator in attempts to sell the big-boss first, or to get an order from city hall. (3) Confusing methods of presenting prices. (In this regard Mr. Nalefski cited the clean-cut method of quoting practiced by chemical manufacturers.) (4) The questionable method of establishing local dealer representation in order to allow discounts, or bring local pressure in making sales. (5) Paint and boiler compound salesmen's methods are a real peeve. (6) Using the "Wine, Women and Song" method of getting on the inside seems to be an increasingly doubtful method of building up business of a substantial or lasting nature. If the latter does not work at home the same consideration should be given to it at Conventions, where salesmen are frequently taken advantage of, added Mr. Nalefski.

One might imagine that there was a considerable voice heard from the floor concerning both sides of the picture. However, nothing was said which had not been covered in the two papers and there was no note of disagreement heard on either side. Operators were free to concede that they did learn much from the "Ambassadors of Commerce"—i.e., other than the paint and boiler compound racketeering variety.

"Recent Federal and State Taxation Affecting Water Works" by Clyde H. Hunter, C.P.A., Quincy, Ill.

Although Mr. Hunter's analysis of the taxing situation proved in-

(1) *L. I. Birdsall and Jerry E. Hauer, General Chemical Co., Chicago;* (2) *Dr. A. M. Buswell, Univ. Ill., and John E. Baylis, Physical Chemist, Chicago;* (3) *John L. Ford, Ford Meter Box Co., Wabash, Ind., and Ross J. Burns, Pittsburgh Meter Co., Pittsburgh;* (4) *John A. Goetz, Supt., and F. L. Coventry, Chemist, Matoon (Ill.) Water Dept.;* (5) *John W. Krouse, Chief Engr., La Grange, Ill., and Roy A. Metz, Supt. Water and Sewerage, Carthage, Ill.*

teresting in general, the slight part applicable to water works was a disappointment — chiefly because municipal plants are not affected, and only 10 per cent of the 625 public water supplies of Illinois are company owned. Concerning Federal control of wages and hours, there had been no complaint of note from water utilities.

In Illinois, Social Security operated by the State extends to municipal employees if the city chooses to contribute the required 3½ per cent on wages and limited salaries. The employee contributes the difference required to provide the security pension of $10.00 weekly minimum. Amongst others, Quincy had recently adopted this optional system. He mentioned Senate Bill 202, prescribing for payment for main extensions by assessing properties benefited. He said it would probably pass.

As to Federal Income Taxes, now paid by all municipal employees as well as others, Mr. Hunter listed what is in store if the proposed Treasury revision goes into effect for net salaries and income. These are:

Net Income	Present Tax	Proposed Tax
$2,500	$ 11	$ 72
$3,000	31	152
$4,000	70	312
$5,000	110	506

Astounding Supreme Court Decision Revealed

"Water Supply Problems and the Manteno State Hospital Typhoid Outbreak" by Clarence W. Klassen, Chief Engineer, Illinois State Dept. of Health, Springfield, Ill.

Mr. Klassen's absorbing and well prepared paper described the Manteno typhoid outbreak, its cause and effect, and cited the astonishing Illinois Supreme Court decisions in the case, which refused to admit the dependability of the standard coli-test as an index of dangerous pollution. The grounds for such are later quoted, the decision reversing the lower court which held the Director of Walfare responsible in not heeding warnings of the State Department of Health of the pollution found in the well supply over a period of several years. The hearings in this case had revealed that the Department had an inadequate power of control over the public water supplies of the State, resulting in getting a bill into the present legislature which will provide the Department of Health with ample powers for correction enforcement.

Mr. Klassen described and pictured by slides the methods pursued at the Manteno hospital under his direction to suppress the disease. Chlorination in heavy concentration was installed. As soon as possible a filter plant was built—providing pre- and post-chlorination. All wastes, including garbage, was disposed of by boiling, evaporation and incineration in 22 coal-fired hanging cauldrons, 300,000 gals. being thus disposed of, requiring 20 tons of coal.

At Manteno 4 deep wells, inadequately cased into limestone, had shown pollution existing for 8 years when, suddenly leaking sewers through rock fissues brought down 453 persons with typhoid and resulted in 60 deaths—the highest death rate per 1,000 cases on record for the U. S. Interestingly, the coli index in Manteno's water had followed in exact parallel the population increase—i.e., the increasing demands on the wells. Of unusual interest is the fact that with the severest pollution (reaching a coli index of 240,000 during the outbreak) typhoid organisms were actually isolated. This instance represents only the 13th time on record for such isolation from a water supply.

Mr. Klassen's paper disclosed that the Department had repeatedly submitted warnings to the hospital authorities, and recommended chlorinaion without avail. As a result the State Director of Welfare was tried and indicted for disregard of duty and negligence. An appeal brought the case to the State Supreme Court, resulting in reversal of the trial court's verdict of guilty. The new verdict was based on the Court's contention that, since nothing had happened during the 8 years of so-called danger warnings of the coli test that such findings rather proved the source of supply safe than to the contrary. Since this decision of one of the country's highest courts constitutes the first interpreation of its kind on record, to our knowledge; and will rather astound public health authorities who will be faced with the question of what must be done to prove conclusively that water supply containing colon organisms in excess of the permissible coli index is actually dangerous, it is well to quote certain paragraphs from the decision in the exact words of the Court, to wit:

"These analyses of drinking water are made by chemists and bacteriologists and not by medical doctors, nor by any one qualified to express any medical opinion" * * * "The most that can be said for any of these 158 exhibits, is that it showed the water to be either positive or negative as to coli aerogenes." * * * "It appears from the record that coli aerogenes or colon bacilli in water may be friendly or inimical, and that the mere presence of colon bacilli in water proves exactly nothing, so far as typhoid fever is concerned. * * * * "It further appears that this type of bacillus is present in the air one breathes, in milk, on fruit and practically everywhere."

"It is further apparent that colon bacillus may be of the fecal or non-fecal type and that so far as typhoid is concerned, it is only the fecal type from man alone (not other animals) that can spread disease. The typhoid bacillus could not possibly have been identified by the laboratory means used in any of these reports (Referring here to the standard water examination involved prior to the outbreak.—Ed.) and none of them is of any value to the People in an attempt to prove the guilt of the defendant." "Even if these reports were of any probative value they would necessarily tend to

(1) *Clifford Fore, Supt. Filtration, Carbondale, Ill.;* (2) *R. W. Rowley, Cliffs-Dow Co., Marquette, Wis.;* (3) *Wm. J. Hodgson, Engr. Pumping, Pekin, Ill.;* (4) *Geo. R. Young, City Manager, Glencoe, Ill.;* (5) *H. A. Tolburg, Neptune Meter Co., Springfield, Ill.;* (6) *Otto Reynolds, The Leadite Co., Kansas City, Mo.;* (7) *B. P. Spann, Publicity Mgr., Gardner-Denver Co., Quincy, Ill.;* (8) *James Moran, Supt. Filtration, Princeton, Ill.;* (9) *Cy Bird, Chicago Manager, the Pitometer Co.*

disprove, rather than prove a case against the defendant. The water from these wells was consumed by all the inhabitants of Manteno for more than 8 years prior to this epidemic. This test (for coli) over a period of 8 years, if looked upon as a laboratory experiment, would go a long way toward proving that the water was actually safe for human consumption, because there is no evidence of any abnormal condition as typhoid occurring during that period of time. It is difficult to think of any better proof that could be offered that the water was free from the typhoid bacillus and that the epidemic was not water borne." (The underlining is ours.—Ed.)

[We submit that ordinarily this astounding decision would be something to think about. But, it was brought out in the discussion following Mr. Klassen's paper, that the methods pursued in the prosecution of the venerable and highly regarded Director of Welfare, and consideration of his record, had all to do with the Supreme Court's acquittal.—Ed.]

Operators' Session

Chas. H. Spaulding, Springfield, Ill., presiding.

This was the session in which operators came prepared to tell the world (hopeful that designing engineers would hear too) what is wrong with water works design from the operators' viewpoint.

Topic: **Items Which Should Be Considered in the Design of Water Works Plants from the Operators' Standpoint.**

W. M. Olson, Sup't. of Filtration at Winnetka, Ill., was first on the list. His severel suggestions included the following: Fuel oil tanks get sludged and should be provided with a clean-out manhole; provide cooled water fountains for visitors; open basins should be provided with a hand hold above water line to preclude drowning of those who may fall in; the raw water Venturi tube should be ahead of carbon application to preclude sludging; for holding or conveying carbon suspensions corrosion resitant materials (C.I., copper, rubber hose) should be employed; wherever carbon is applied a short rapid mix should be provided; filtered water storage basins should be of a design permitting removal from service for cleaning; there should be an emergency source of power for operating all plant units; all water into and out of plant should be accurately metered.

F. L. Coventry, Sup't. of Purification, Mattoon, Ill., had the following suggestions:

Dry feed machines are usually too few; recomended minimum of 3 for coagulation and 5 for softening. (At this point someone whispered in our ear—Chicago is to have 55 dry feeders in its new filter plant.) In disposal of softening sludge, a concentrating or thickening tank should provide for return of supernatant and drawing off a sludge of 5 per cent solids or better. Recarbonation equipment is commonly too small, because 10 per cent CO_2 is about as rich as practical and liquid scrubber losses amount to 25 per cent; diffuser plates become clogged and 1/32 in. perforated grids permit marked loss of CO_2 at surface. Believes that allowances for a 40 per cent overall waste to be the correct figure for CO_2 in recarbonation.

Regarding clear wells, there should be a bypass from filter effluent header direct to pumps to permit work in clear well while out of service; provide rings in the ceilings for lifting pumps, etc.; check valves should be located as far as practical beyond pumps; chlorine bleed vents should be provided for degassing all chlorinators; visitors do not think that down spouts from roofs should spill into filters or basins; some scheme for saving of expensively treated basin water, incident to basin drainage for cleaning, should be provided.

John Baylis, in reply to a question, stated that no decision had been reached concerning sludge disposal at the Chicago plant. It may have to be carted away at cost of $100 per day.

Linn Enslow wondered if this valuable "precipitated chalk" from softening might not be taken by paper board or box-board plants for use as "filler," since precipitated chalk of commerce is used for this purpose in producing many filled papers and cardboard. Possibly some mill might even pay for the material, in addition to hauling it away. Sewage sludge is sold in this manner and softening sludge might well be found marketable at some profit.

Clifford Fore, Sup't. of Filtration, Carbondale, Ill., agreed with Coventry that hoisting facilities are important to operators. He added that chemical storage arrangements are usually weak, and chemical lines should run to several points. The larger the outlet from settling basins the better.

Mr. Spaulding (presiding) in answering a question, stated that the order of chemical application sometimes made quite a difference. In softening, if iron is the coagulant it functioned to better effects when added ahead of the lime when efficiently dispersed. Alum, on the other hand, did a better job following the lime.

G. H. Ruston, Sup't. of Water, Kenilworth, Ill., recommended design to relieve operators of janitor work by leaving out dust collecting ornamental works and providing dust prevention equipment; provision of more adequate floor slopes to drain sumps; suggested a portable revolving wire brush for cleaning piping, flanges, etc., preparatory to painting; bolt heads, most difficult to clean, should be cadmium plated; a complete set of all small tools and accessories to be required should be supplied with every new plant, as part of the

(1) *P. F. Pew, Mgr. Munic. Sales, International Filter Co., Chicago;* (2) *W. M. Olson, Supt. Filtration, Winnetka, Ill.;* (3) *Fred Geyer, Rensselaer Valve Co., Chicago;* (4) *David A. Decker, Sales Engr., Johns-Manville, Chicago;* (5) *O. J. Theobald, Jr., Mathewson Alkali Co., St. Louis, Mo.;* (6) *Hume G. Richards, Badger Meter Co., Milwaukee;* (7) *Frank C. Roe, Mgr. San. Sales., Carborundum Co., Niagara Falls;* (8) *D. O. Meek, Chief Design Engr., Gardner-Denver Co.;* (9) *Fred H. Brune, Dist. Mgr., Renesselare Valve Co., Chciago.*

construction contract. A complete set of manufacturers' instructions should also be supplied for various equipment, preferably an extra set for the safe.

M. M. Symons, Chief Engr., Danville, Ill., convinced that every designer should serve an apprenticeship as a plant operator, related troubles with adjustments on a popular make of dry-feeder and decided to build his own at a cost of $17.45. He said that he could recommend the Symons Feeder as easy to adjust and adequately accurate.

Pumping Stations and Distribution Design

A. E. Anderson, Sup't. of Water, Moline, Ill., plead for greater accessibility of valves, checks, etc., in pumping stations and valve pits. In pits clearance should be 4 in. as minimum between wall and valves.

J. O. Forten, Sup't. of Water, Glen Ellyn, Ill., advocated making manholes oval shaped to permit two men to work together face to face in them, the long way of the oval to be 40 inches as minimum, better 48 inches.

S. T. Anderson, Springfield, Ill., mentioned Eastman's "Recordak," a form of camera for reproducing plans, sketches and other documents. The equipment, procurable on a rental basis, had been a great boon to the Springfield Water and Light Department. He suggested that the operator should examine plans for weaknesses ahead of construction, and not later pin all the blame on the engineer.

H. S. Merz, Sup't. of Water, Rockford, Ill., contributed amongst other suggestions the following: Steam boilers might be set higher to advantage; Venturi meters located only in readily accessible locations or pits; mains in general larger; and, recording equipment supplied for metering study.

Control of Well Drilling by H. L. White, San. Engr., Univ. of Illinois, Urbana, constituted a report of the section's Committee on Well Drilling, of which Mr. White is chairman. The report stated that well contractors as well as municipal officials were all for regulation of well drilling practices and control of ground water takings. The committee recommended that the State Department of Health, with 21 District Engineers on the job, should be entrusted with ground water regulation, rather than other State agencies as at present. Under the present Act of 1939 obtaining of a drilling permit had amounted to little more than the filing of intent to drill at a specific location. The Section, by resolution, voted and endorsed the recommendation that ground water control be transferred to the Department of Health and that the good work of Mr. White and his committee be continued.

National Defense Session

Chairman-Elect, H. H. Gerstein, presiding.

The closing session on the third day was devoted to "Water Supply in the National Defense Program." It proving necessary for this reporter to leave the meeting before this session it is possible to give the papers presented only in a very sketchey fashion.

The **"General Problem"** was first outlined by *Mr. Paul Hansen,* Consulting Engineer of Chicago, with specific considerations to midwestern areas not concerned with the likelihood of aerial bombing attacks. The most interesting portions of Mr. Hansen's review was a review of the types and design of water supplies for cantonments and military bases in Illinois, comprising combinations of a domestic supply from wells and general supply from surface sources, for the most part involving filtration or softening plants.

"Protection of Water Works Against Sabotage" as discussed by Mr. Joseph Horn, Special Agent from the F.B.I. Office in Springfield, Ill., constituted a general statement as to the workings of spys and saboteurs, and basic protective measures designed to defeat their aims and intent to damage essentil plants in general. Mr. Horn particularly stressed the need for careful scrutiny of employees. He also urged water works managers to communicate information, which might prove of importance to the F.B.I., to their nearest agent. The dovetailing of such bits of information from several sources might well disclose a picture of importance otherwise unobtainable.

Experiences in **"Building Cantonment Water Supplies Under Difficulties"** were related by Chas. B. Burdick, of Alvord, Burdick and Howson, Chicago engineers, responsible for a number of these systems rushed to completion in 4 to 5 months whereas in no emergency 2 years would be required for the same job. Unlike supplies for cantonments in World War No. 1 the modern mechanization of armies required far larger base areas for training, and locations far removed from municipalities which might otherwise be drawn upon rather prevalently for water supply as in World War No. 1.

President N. J. Howard scheduled to review **"Canadian Experiences in Protecting Water Plants"** was prevented from delivering his talk, due to the necessity of returning to Canada after the second day of the meeting.

The meeting closed with the afternoon inspection trips to the Quincy Water Works, and the pump manufacturing plants of the Gardner-Denver Co. and the Dayton-Dowd Co.

EXPERIMENTAL DIGESTION

A Study of the Efficacy of Activated Carbon on Digester Behavior and Sludge Quality at Lancaster, Pa.

By GORDON J. WIEST
Chief Chemist,* Sewage Treatment Works
CHESTER, PENNA.

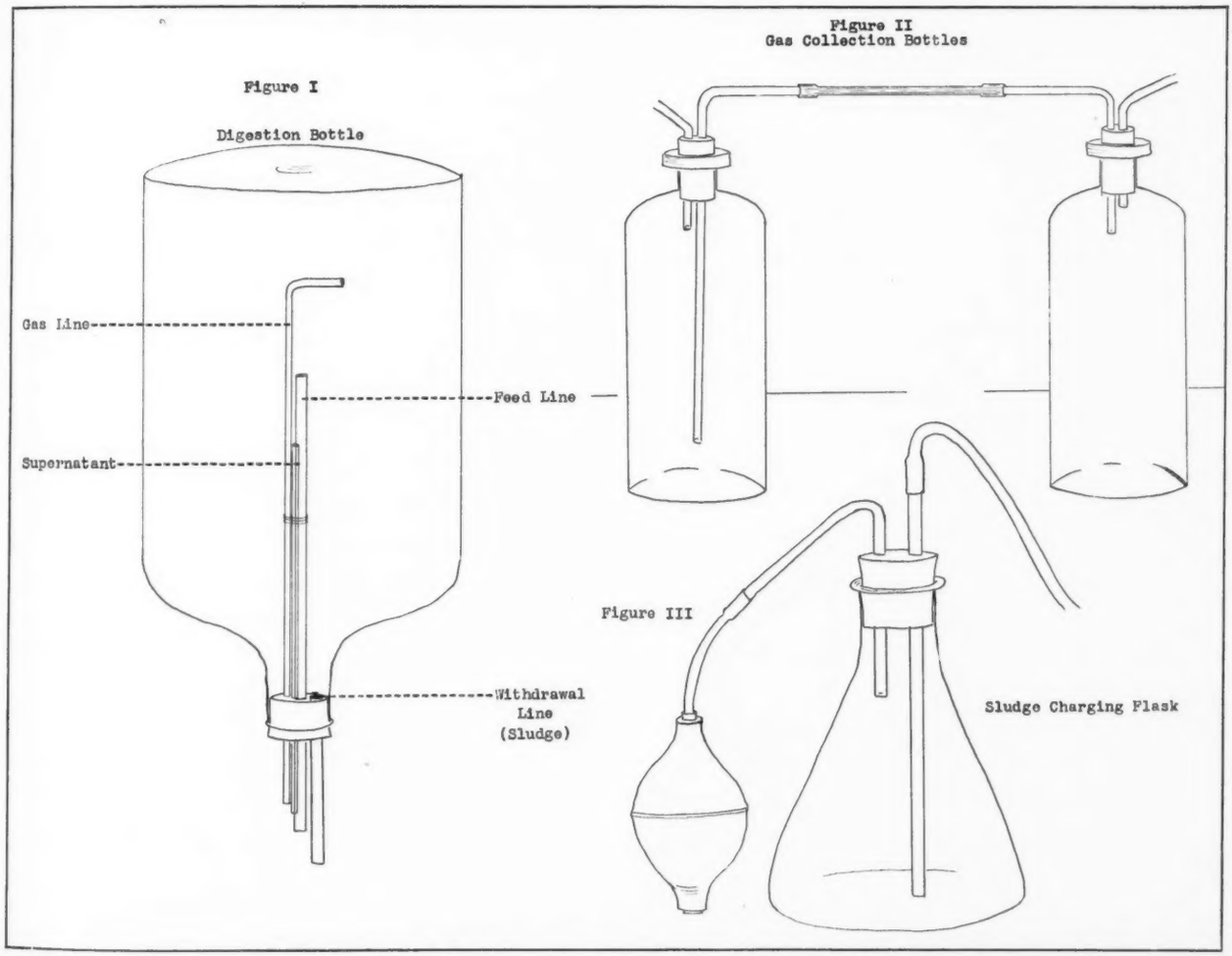
A NUMBER of sewage works operators and investigators have reported on the effects of activated carbon on sludge digestion. The results have varied widely and with rather slight correlation, but no attempt will be made here to abstract the results of these earlier studies and plant scale measurements which have been reported in the literature for the most part.

The South Sewage Treatment Works of Lancaster, Pa., placed in operation during May, 1935, had experienced a variety of operating difficulties with sludge digestion and disposal. With these experiences fresh in mind, it was decided to initiate a series of experimental digestion studies and plant scale measurements to determine the effects of activated carbon on sludge digestion. The effects of carbon were studied in parallel with the effects of hydrated lime, which has been so widely employed as an aid in digestion.

The Author

*Previously, Chemist in Charge of the Sewage Treatment Plants of Lancaster, Penna.

The experimental studies were planned to be carried on while employing a continuous digestion procedure, rather than a "batch" digestion procedure. That is, fresh sludge additions were made to the experimental digestion units daily in a manner to closely parallel actual plant practice. The studies were planned so that observations and measurements were made of the various factors by which sludge digestion practice is evaluated. The speed of digestion was measured by the rate of gas production, the volume of gas produced per unit weight of vola-



Sketch of Apparatus Used in Digestion Studies

Fig. 1—Digestion Vessel; Fig. 2—Gas Collection Bottles in Series; Fig. 3—Sludge Charging Flask, for Forcing Sludge Into Digester.

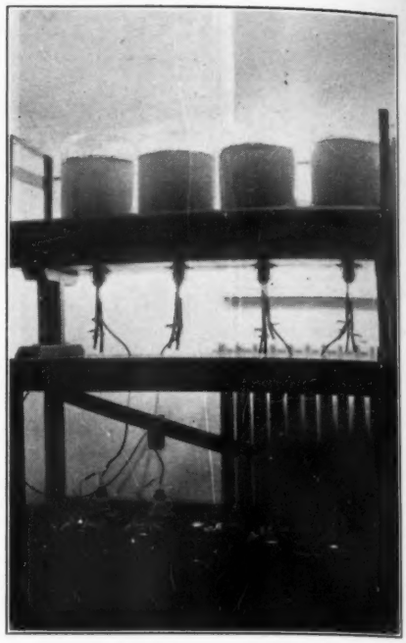
D'Orsat Gas Analysis Apparatus.
(*Gas collection bottles in foreground.*)

tile solids added, and by the apparent reduction of the volatile solids content of the digested sludge. The quality of digestion was determined by the methane content of the gas produced and from the analytical data of the supernatant liquors. The drainability tests of the digested sludge were used to evaluate its dewatering properties incident to effective drying on sand beds or vacuum filters.

The data reported here is a summary of three separate experimental digestion studies. In addition, data is given which resulted from plant scale applications of activated carbon to digested sludge incident to dewatering and drying on open drying beds.

Digestion Apparatus

Nineteen-liter glass bottles (8 in all) were fitted up to serve as digestion units. The digesters were placed in a room adjoining the laboratory and were held in a neck-downward position by a frame built for this purpose. The temperatures of the digesters were controlled by the temperature of the room, which was prepared to maintain the varying temperature conditions planned for the experimental operations. Actual plant conditions were duplicated insofar as practicable, and each digester was fitted in a parallel manner. A volume of 16 liters of each digester was used for sludge digestion and the difference (three liters)



Portion of Battery of Eight Digesters in Temperature Controlled Room.

Table I
Experimental Digestion Studies
Lancaster, Pa.

Study	Digestion Unit	Treatment		Aver. Temp. of Digestion	Total Days of Operation	Vol. Sludge Added/Day C.C.	Aver. Grams of Solids added/Day		Speed of Digestion							
									Gas Production			Percentage Volatile Solids in Digesting Sludge				
		Dosage	Chemical				Total	Volatile	Average Day C.C.	Total C.C.	C.C. Gas/Gr. Volatile Solids added	30 Days	60 Days	90 Days	120 Days	Completion
Series I	1	2 p.p.m.	Activated Carbon	86	101	800	19.13	15.36	4701	451,280	291	72.73	63.62	63.14		62.91
	2	2 p.p.m.	Activated Carbon	86	101	800	19.13	15.36	4587	440,370	284	73.91	62.52	61.92		61.59
	3	4 p.p.m.	Activated Carbon	86	101	800	19.13	15.36	4529	434,770	280	72.76	62.68	61.03		60.36
	4	6 p.p.m.	Activated Carbon	86	101	800	19.13	15.36	4405	422,860	273	72.36	61.22	60.82		58.83
	5	2 p.p.m.	Hydrated Lime	86	101	800	19.13	15.36	3581	343,790	222	74.09	61.40	60.74		60.22
	6	4 p.p.m.	Hydrated Lime	86	101	800	19.13	15.36	3864	370,980	233	74.06	58.44	61.15		62.40
	7	6 p.p.m.	Hydrated Lime	86	101	800	19.13	15.36	4228	405,860	262	74.19	59.83	61.03		60.11
	8	Control	None	86	101	800	19.13	15.36	4313	414,020	267	74.26	61.04	61.61		61.23
Series II	1	2 p.p.m.	Activated Carbon	62	102	800	30.72	23.13	155	15,700	7.1	70.65	68.86	67.29		67.73
	2	2 p.p.m.	Activated Carbon	62	102	800	30.72	23.13	149	15,320	6.9	71.06	68.95	67.94		67.71
	3	4 p.p.m.	Activated Carbon	62	102	800	30.72	23.13	151	15,570	7.0	70.31	66.18	68.86		68.16
	4	6 p.p.m.	Activated Carbon	62	102	800	30.72	23.13	139	14,310	6.5	69.52	69.73	69.10		68.57
	5	2 p.p.m.	Hydrated Lime	62	102	800	30.72	23.13	142	14,640	6.6	70.45	68.95	68.76		69.23
	6	4 p.p.m.	Hydrated Lime	62	102	800	30.72	23.13	144	14,820	6.7	69.17	68.91	69.14		68.13
	7	6 p.p.m	Hydrated Lime	62	102	800	30.72	23.13	145	14,900	6.7	71.15	69.16	68.45		67.43
	8	Control	None	62	102	800	30.72	23.13	134	13,820	6.3	71.87	69.75	69.87		69.54
Series III	1	2 p.p.m.	Activated Carbon	88	155	800	31.60	23.72	6063	939,780	255	72.14	69.10	67.75	67.21	62.78
	2	2 p.p.m.	Activated Carbon	88	155	800	31.60	23.72	6080	942,520	256	71.78	68.87	67.54	67.34	62.21
	3	4 p.p.m.	Activated Carbon	88	155	800	31.60	23.72	6158	954,580	259	71.52	68.92	67.92	67.18	63.14
	4	6 p.p.m.	Activated Carbon	88	155	800	31.60	23.72	6177	957,400	260	71.62	68.66	67.63	67.36	62.94
	5	Control	None	88	155	800	31.60	23.72	6033	935,180	254	72.85	69.95	69.15	68.91	65.15

Table II

Experimental Digestion Studies
Lancaster, Pa.

Study	Digestion Units	Treatment: Dosage	Treatment: Chemical	Quality of Digestion: Gas Analysis % Methane: 30 Days	60 Days	90 Days	Final	Supernatant Liquors Suspended P.P.M.: 30 Days	60 Days	90 Days	120 Days	Solids Concentration	Supernatant Liquors B.O.D. (5 days) P.P.M.: 30 Days	60 Days	90 Days	120 Days	Concentration	Supernatant Liquors Hydrogen Sulfide P.P.M.: 30 Days	60 Days	90 Days	120 Days	Concentration	pH Digesting Sludge: 30 Days	60 Days	90 Days	120 Days	Concentration
Series I	1	2 p.p.m.	Activated Carbon	43.6	57.6	61.4	62.8	262	1208	958		1010	1100	1250	1000		990	22.6	57.5	29.2		26.6	6.7	7.3	7.8		8.0
	2	2 p.p.m.	Activated Carbon	36.8	54.6	62.6	66.2	238	1452	1140		1156	1400	1550	900		950	24.3	46.7	26.2		26.0	6.7	7.3	7.6		7.9
	3	4 p.p.m.	Activated Carbon	34.8	39.8	51.8	56.8	262	2716	1524		1238	1500	1900	850		900	26.9	48.1	27.2		26.0	6.7	7.4	7.8		8.0
	4	6 p.p.m.	Activated Carbon	31.6	39.8	56.8	56.8	342	3428	1468		1259	1850	1450	550		900	25.6	58.4	29.4		27.2	6.7	7.4	7.8		8.0
	5	2 p.p.m	Hydrated Lime	27.8	36.8	39.8	41.8	250	1512	826		1436	1450	1250	1720		1560	26.8	46.5	29.6		28.0	6.7	7.4	7.8		8.0
	6	4 p.p.m.	Hydrated Lime	32.6	34.8	42.8	44.8	310	1784	1576		1612	1650	1350	1150		1210	29.8	49.6	38.4		33.2	6.7	7.3	7.8		8.0
	7	6 p.p.m.	Hydrated Lime	32.8	34.2	36.2	39.6	320	1040	1274		1789	1750	1350	1550		1320	32.0	43.8	31.8		35.4	6.7	7.3	7.8		8.0
	8	Control	None	29.4	38.8	46.6	42.2	328	1048	596		1495	1600	1750	2050		1950	30.2	49.9	30.8		35.4	6.7	7.3	7.6		7.9
Series II	1	2 p.p.m.	Activated Carbon	30.6	34.5	39.9	41.6	961	2136	2360		2318	1930	2580	3000		3100	41.7	46.9	37.6		37.1	5.4	5.3	5.9		5.9
	2	2 p.p.m.	Activated Carbon	28.6	31.4	40.8	39.7	878	2098	2230		2561	1390	2670	2960		2760	42.4	49.5	39.5		37.2	5.4	5.3	5.9		5.9
	3	4 p.p.m.	Activated Carbon	27.7	31.6	37.9	46.1	903	2236	2470		2910	1520	2540	2500		2390	57.6	49.6	39.7		41.3	5.4	5.2	5.9		5.9
	4	6 p.p.m.	Activated Carbon	29.6	38.6	41.2	45.4	953	2546	3190		3231	1370	2530	2966		2860	49.2	46.6	39.8		31.5	5.3	5.3	5.9		5.9
	5	2 p.p.m	Hydrated Lime	24.6	27.2	37.1	37.9	895	2345	3370		3346	1530	2520	2760		2910	62.6	56.6	53.1		50.0	5.4	5.2	5.9		5.9
	6	4 p.p.m.	Hydrated Lime	27.2	26.6	33.2	39.4	1061	2368	3260		3410	1960	2590	2940		2640	49.3	63.6	56.4		52.4	5.4	5.2	5.9		5.9
	7	6 p.p.m	Hydrated Lime	27.1	33.2	36.2	37.4	985	2587	3490		4490	1330	2650	3100		2990	56.9	65.3	56.6		51.2	5.4	5.3	5.9		5.9
	8	Control	None	19.2	31.1	29.9	36.6	1179	2789	4490		3917	1780	3000	3900		2990	61.4	68.4	62.9		60.6	5.3	5.2	5.6		5.7
Series III	1	2 p.p.m.	Activated Carbon	33.4	49.6	69.3	67.9	362	417	345	349	237	890	1030	880	880	610	35.2	38.9	34.2	28.4	14.0	7.3	7.4	7.5	7.6	7.7
	2	2 p.p.m.	Activated Carbon	34.4	50.2	68.7	68.5	309	333	324	307	278	910	1000	900	880	620	36.6	39.6	35.1	28.3	14.6	7.3	7.4	7.5	7.6	7.7
	3	4 p.p.m.	Activated Carbon	32.7	59.7	69.1	69.7	382	324	314	324	266	870	1000	970	870	630	36.8	39.4	36.1	23.4	14.4	7.3	7.4	7.5	7.6	7.6
	4	6 p.p.m.	Activated Carbon	34.7	57.6	69.5	69.8	324	307	342	345	282	870	1050	970	890	630	38.5	38.5	35.0	27.6	15.3	7.3	7.4	7.5	7.6	7.6
	5	Control	None	33.6	47.9	63.9	62.2	397	278	390	332	304	900	1160	1000	930	710	37.2	42.9	47.3	44.2	30.5	7.3	7.4	7.3	7.4	7.3

as gas space. The gas produced was measured and collected by the displacement of a prepared solution in bottles connected separately to each digester.

Early in the experimental operations it was observed that the adsorption of carbon dioxide in the water used in the gas displacement bottles effected the accuracy of the gas analyses. This was corrected by preparing a 10 per cent solution of sodium sulphate, made slightly acid with hydrochloric acid, for use in the gas displacement bottles. Throughout each digestion study the same displacement liquid was used in each pair of bottles connected to the digesters for gas collection and measurement. The fresh sludge added daily to each digestion tank was done by developing pressure with an atomizer bulb attached to a flask containing the sludge. The rate of addition was controlled as much as possible; however, no *actual* rate of addition may be accurately reported. The new sludge, added to each digester daily throughout the experimental operations, was a mixture of fresh sewage solids and waste activated sludge removed from the primary settling tanks of Lancaster's South Sewage Treatment Works.

Very early in the experimental operations, observations indicated that the introduction of air during daily sludge additions constituted a problem. This was corrected by attaching the gas delivery line to a parallel pair of bottles, arranged similarly to the gas displacement bottles, during the time of sludge additions to each digester. Thereby, when supernatant liquors and digested sludge were withdrawn, there was a balanced pressure in the connected bottles to the digester, and, as the sludge addition was made the pressure was returned to the digester without effecting a built-up pressure. In this arrangement the introduction of air into the digestion vessel was prevented.

Gas analyses were made by using a rebuilt D'Orsat Apparatus. The methane was determined by slow combustion.

TABLE III

Average Raw Sludge Analyses

Study—	Series I	Series II	Series III
Total Solids (%)	2.8	3.8	3.9
Vol. Solids (%)	79.9	75.3	75.1
Ash (%)	20.1	24.7	24.9
Alkalinity (p.p.m.)	...	658.	660.
H_2S (p.p.m.)	...	14.7	14.0
pH	6.2	6.3	6.3
Temperature °F	72	64	75

TABLE IV

Average Analyses of Raw Sewage (Results in P.P.M.)

Study—	Series I	Series II	Series III
Total Solids	796	798	804
Volatile Solids	558	322	547
Suspended Solids	214	270	210
Dissolved Solids	582	528	594
B.O.D. (5 day)	180	186	220
Nitrogen as NH_3	14	24	27.5
Chlorides	103	95	89
Hydrogen Sulphide	5.0	6.0	6.8
pH Value	7.5	7.4	6.8
Temperature °F	72	66	74

The Drainability Test

The drainability of the digested sludges from each digester was determined at the completion of each digestion study by applying parallel measured quantities of the digested sludges on drying areas of experimental sand-filter boxes constructed as described by Professor L. V. Carpenter. The limited quantity of digested sludge available from each digester made it necessary to subdivide each experimental filter box into four quarters so that each volume of digested sludge was applied to a drying area of 1 square foot. Laboratory drainability tests using the Buchner Funnel "break" test were not carried out because of unsuccessful efforts with the vacuum apparatus available. Photographs and sketches of the experimental apparatus are shown with this article.

Experimental Routine

Three separate experimental sludge digestion studies are being reported here. These studies were preceded by a trial experimental study, the results of which are not included here. The preliminary test served a useful purpose in revealing previously unsuspected sources of error and can be highly recommended to other investigators. The three studies are designated as Series I, Series II and Series III. Table I summarizes the data obtained from all three studies.

In each study the digesters were started by adding sixteen liters of crude (raw) sewage. No seed sludge was added or used in any of the experimental studies reported here. Attention is again called to the fact that all of the experimental studies described here were operated as a continuous digestion procedure, and were not carried on in a "batch" digestion manner. The average analysis of the crude sewage during each study is shown in Table IV. The crude sewage was allowed to set at the prescribed temperature for each study for 48 hours, after which the daily or periodic additions of fresh sludge was started. The sludge was exactly alike in all respects in each case except for varying dosages of activated carbon and hydrated lime. A control digester (that is, one digester which received fresh sludge only with no chemical additions) was carried along in an otherwise parallel manner with each separate study.

A sample of each fresh sludge addition to the digester was composited for laboratory examination. The characteristics of the fresh sludges used in the experimental operations are shown in Table III. The

Table V

Experimental Digestion Studies Lancaster, Pa.

Study	Digestion Unit	Treatment		Drainability of Digested Sludge				
		Dosage	Chemical	% Moisture Reduction				
				3 Days	6 Days	9 Days	12 Days	15 Days
Series I	1	2 p.p.m.	Activated Carbon	36.2	44.2	50.8	55.1	57.8
	2	2 p.p.m.	Activated Carbon	41.2	48.7	52.1	54.7	58.2
	3	4 p.p.m.	Activated Carbon	33.9	36.7	39.9	54.2	62.1
	4	6 p.p.m.	Activated Carbon	36.2	38.2	50.4	56.5	64.4
	5	2 p.p.m.	Hydrated Lime	31.1	35.6	39.2	43.3	48.0
	6	4 p.p.m.	Hydrated Lime	27.9	34.3	39.5	43.1	47.1
	7	6 p.p.m.	Hydrated Lime	31.0	32.4	35.4	36.0	36.6
	8	Control	None	31.0	33.5	34.6	38.3	41.0
Series II	1	2 p.p.m.	Activated Carbon	38.6	42.9	44.2	46.9	49.9
	2	2 p.p.m.	Activated Carbon	38.5	41.7	43.0	47.5	49.0
	3	4 p.p.m.	Activated Carbon	38.8	42.6	42.8	44.2	44.9
	4	6 p.p.m.	Activated Carbon	39.7	42.7	43.3	44.7	50.1
	5	2 p.p.m.	Hydrated Lime	32.1	34.7	35.5	37.4	39.2
	6	4 p.p.m.	Hydrated Lime	32.1	33.9	35.1	35.5	37.0
	7	6 p.p.m.	Hydrated Lime	29.5	30.7	31.8	34.1	37.4
	8	Control	None	34.7	37.4	37.8	38.7	39.2
Series III	1	2 p.p.m.	Activated Carbon	36.6	39.1	41.9	43.6	44.9
	2	2 p.p.m.	Activated Carbon	36.8	39.2	41.5	42.9	43.3
	3	4 p.p.m.	Activated Carbon	37.4	40.1	41.2	43.7	44.1
	4	6 p.p.m.	Activated Carbon	37.1	39.8	41.1	43.1	44.3
	5	Control	None	33.4	35.4	37.5	39.7	40.2

sludge additions were within prescribed loading limits in all cases, and each increment was thoroughly agitated with the chemical dosages prescribed. The apparatus described for preventing the introduction of air was used throughout the experimental operations.

In Series I and Series II 800 cubic centimeters of fresh sludge were added daily and the chemical dosing was based on the average raw sewage flow at the South Sewage Treatment Works, which was 5.1 million gallons daily. The chemical dosages were specifically; as follows: 2 p.p.m., 4 p.p.m., and 6 p.p.m. activated carbon, and 2 p.p.m., 4 p.p.m., and 6 p.p.m. hydrated lime.

In Series III Study 800 cubic centimeters of fresh sludge were added daily to each digester and the chemical dosages were again based on the average flow of raw sewage. In the chemical treatment, hydrated lime was used for maintaining the pH of the digesting sludge between 7.3 and 7.4, plus specific dosages of activated carbon; as follows: 2 p.p.m., 4 p.p.m., and 6 p.p.m. The control digester in this case was treated with hydrated lime alone for pH control.

A volume of supernatant liquor was decanted from each digester equivalent to the volume of fresh sludge to be added each time. An added volume of 150 cubic centimeters of supernatant liquors was removed from each digester for use in mixing the respective dosages of activated carbon and hydrated lime.

This procedure was likewise followed for the control digesters in each study so that the treatment of all sludge additions was maintained in a parallel manner. Samples of the supernatant liquors from each digester were examined daily for pH, alkalinity, hydrogen sulphide, and temperature. Composited samples of the supernatant liquors were examined weekly for solids and bio-chemical oxygen demand. A summary of the analytical data for the supernatant liquors is shown in Table II.

Digested sludge samples were withdrawn weekly from each digester and were examined in the laboratory. A summary of this data is shown in Table I.

Gas analyses were made on a sample from each digester weekly and the volumes of gas were measured as required. Carbon dioxide, oxygen, and methane were determined on each sample, since facilities were not available for a more complete analyses.

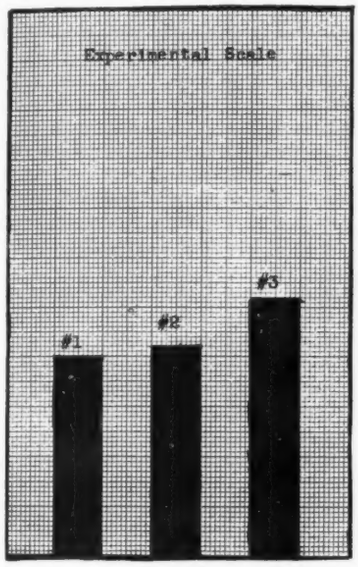
The drainability measurements on each digestion study were made on the separate sludges using the experimental filter boxes at the completion of each study. The drying time observations required a period of 15 days. The percentage moisture of each sludge was determined at the time of application to the drying area and on the sludge cake every three days until the 15-day period was ended. The percentage moisture reduction was calculated in each case. This data is presented in Table V.

Plant Scale Drainability Tests

A plant scale test comparing the drainability of digested sludge treated with activated carbon and untreated digested sludge was carried out at Lancaster's South Works when the problem of sludge disposal became acute. Previously, as one of a number of preliminary corrective measures, alum had been tried as a conditioning agent for the digested sludge applied to the plant drying beds. The treatment with alum was not successful since the total drying time was not sufficiently decreased. In the plant scale test with activated carbon, the activated carbon was added to the digested sludge before application to the drying bed. The quantity applied was 1 per cent of the volatile solids present in the sludge. This dosage was chosen as the result of earlier small scale experimental results.

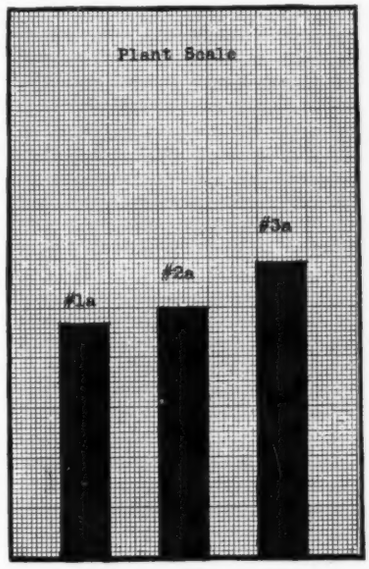
The activated carbon treated sludge dried in one-third the time of the untreated sludge, and this method of treatment afforded an approach to the solution of our problem at a reasonable cost. The comparison of the percentage moisture reduction of the digested sludge applied to the plant drying beds treated with alum, with activated carbon, and the parallel untreated bed is shown on Graph B. The percentage moisture reduction of an experimental test comparing alum treated, activated carbon treated, and untreated digested sludge is shown on Graph A.

Graph A



No. 1 Untreated, No. 2 Alum Treated, No. 3 Activated Carbon

Graph B



No. 1a Untreated, No. 2a Alum Treated, No. 3a Activated Carbon

Graphs A and B—Rates of Sludge Drying, With Alum vs. Activated Carbon, on Experimental and Plant Scale.

Summary

The results of the experimental studies are inconsistent in some respects; however, there are upon careful evaluation two findings which were very definite in each study. (1) The quality of digestion, as evidenced by the percentage of methane content of the gas produced, was higher in each study for the activated carbon treated sludges than the sludges treated with hydrated lime. (2) The drainability of the activated carbon treated sludges was better than the sludges treated with hydrated lime. The improved drainability of digested sludges treated with activated carbon was, thereafter, further confirmed by the plant scale test described.

The basis of determining the optimum dosages of activated carbon for the most effective treatment points to treatment with small quantities of activated carbon rather than large dosages. The real interpretation of the variable dosages of activated carbon applied to digesters remains to be found after a period of actual plant practice, which we believe would be well justified.

The use of hydrated lime as conditioning agent for digesting sludge has its value in the operation of digesters until such a time that measurements and observations indicate that optimum digestion reactions have been reached. After optimum digestion reactions are attained, it appears that the use of hydrated lime has very little value. This observation has already been expressed by others. The use of small dosages of activated carbon, together with hydrated lime for pH control, offers a method of speeding up the digestion reactions to the point at which activated carbon treatment becomes the most effective.

Since this is a summary of three separate experimental digestion studies, and in order to present as truly representative data as possible for comparison, the observations and measurements reported in tabular form were divided into periods of 30 days, 60 days, 90 days, and so forth.

In Series I the rate of gas production shows that the digesters treated with activated carbon were best and this is confirmed by other indices. Series II results are unusual in some respects, which might be explained by the low temperatures maintained in the operation of these digesters; however, the activated carbon treated sludges did show slightly better gas production than those treated with hydrated lime. In Series III the rate of gas production increased, with the gas indices decreasing to perhaps a more steady variation. In Series I, Series II and Series III the observed differences in reduction of volatile solids, between the activated carbon and hydrated lime treated sludges, is very slight and possibly of very little significance.

The quality of digestion, as shown by the percentage of methane content of the gas produced, shows better quality for the carbon treated sludges in every case. It should be noted, too, that the methane content of the gas produced increased to higher values in a shorter period of time in the Series III run, where the treatment of the sludge with activated carbon was supplemented with hydrated lime for pH control.

Activated carbon treated sludges produced better quality supernatant liquors throughout the experimental studies. The hydrogen sulphide determinations reported for the supernatant liquors of Series I, Series II and Series III indicate a consistently higher quality for the activated carbon treated sludges.

The pH of the digested sludges did not indicate any great differences excepted in Series III where hydrated lime was used for pH control. The hydrated lime treatment in Series III was continued longer in the control digester than was the case in the digesters treated with activated carbon.

The drainability of the carbon treated digested sludges was better in every case, such being later confirmed in the plant scale test.

Acknowledgments

The Lancaster Sewage Treatment Works is under the supervision of the Department of Streets and Public Improvements; Daniel W. Coulter, Director; J. Haines Shertzer, City Engineer, and Edward J. Rhoads, Superintendent. In the laboratory work Robert M. Bolenius assisted.

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A Big Stride Toward Elimination of the Auxiliary Fire Supply

OF CONSIDERABLE moment to public health authorities and water works managers has been the long existing problem of cross-connections between private auxiliary fire protection systems and the public water supply mains. Many cases of water-borne disease or intestinal disorders have been traced to infection entering the public supply mains through physical connections with unsafe private systems.

The trend in recent times has been to throw the problem and responsibility of getting these hazardous cross-connections eliminated, or improved to the point of being relatively safe when systematically inspected, on the shoulders of the local water supply management. This development has brought to the water works manager or superintendent an added and a ticklish responsibility which is on the whole unwelcome and, to our thinking, for the most part not justified. To us it would seem that the major responsibility should lie with the plumbing or building inspection and public health agencies, functioning with the aid and cooperation of the water supply authority. For instance, in the case of the privately owned water system the position of the management is somewhat different from that of the municipally operated system when it comes to business and contractual relationship between the water taker and the purveyor. Then, too, the superintendent of a small system may find it a difficult matter to dictate to a customer whose takings constitute the backbone of support of the local system, the loss of which would spell calamity to the finances of the system.

All of this is aside from the question of how much authority any water utility management, publicly or privately financed, may have in entering private property for inspections, or demanding changes in piping layouts on the customer's property. Isn't this in truth the job for a governmental regulatory agency with adequate police and enforcement powers to act when necessary to be hard boiled? In the larger cities where the supply is municipally operated it would seem feasible, by ordinance, to create an inspection and supervisory division, within the water department, to look after all nature of cross connections and plumbing hazards, but the small system and private management will probably always need the aid of outside authority in handling the ticklish and unpopular cross connection problem.

And this leads up to the question of any further need for maintaining private fire systems in any manner cross connected to the public supply. There was a time when the public supply, as a fire service supply for important outlying risks, such as manufacturing establishments, could not be sufficiently relied upon as to continuity in regard to dependability of water in volume and at pressures sufficient to meet fire flow requirements. It was this circumstance which caused the National Board of Fire Underwriters to establish standards of fire water supply that necessitated providing private auxiliary supplies, maintained under complete ownership and supervision of the management of properties insured, in addition to whatever might be expected from the less dependable public system. To avail themselves of a safe supply for drinking and the dual protection afforded by a secondary and a primary fire supply, cross connections were the natural result. And the elimination of many of these older connections becomes the more difficult because of the number of years of their existence, without accidental pollution of the public supply having happened.

Toward the elimination of hazardous cross connections of size, and therefore of first ranking importance, the recently revised standards of the National Board of Fire Underwriters will go a long way, we believe. As reported in our April issue, something of a history making statement was made during the meeting of the New York Section of A. W. W. A. in Syracuse, when an important spokesman for the National Board of Fire Underwriters presented the revised standards of water supply requirements for private fire protection. Taken in contrast with the old standards, such were, according to the Underwriters' spokesman, the best possible indication of the improvements noted in the design, operation and maintenance of public supply systems. Such improvements had sufficiently altered the picture of adequacy and dependability of public systems to permit the new standards recognizing that a connection with a public water supply system of adequate capacity and pressure is now preferred as the single or the primary supply.

To us the importance of the changed attitude of the standard-setting Board of Underwriters justifies the verbatim reproduction of the closing paragraphs in the above referred to paper, presented by Mr. A. C. Hutson.

"As further indicating the value of the changes which have taken place in public water supply systems, and of the present less need of an auxiliary water supply for fire protection when the public water system is ample and reliable, is shown by the revision of the standards of the National Board of Fire Underwriters for the Installation of Sprinkler Equipments. For years these standards read, 'For a standard equipment, *two* independent supplies are required,' and further that 'One or more connections from a reliable public water system of good pressure and adequate capacity furnishes an ideal 'primary supply'." The latest edition of these standards issued in June, 1940, reads as follows:

> "Every automatic sprinkler system shall have at least one automatic water supply of adequate pressure, capacity and reliability. . . . . The necessity for a second supply will depend on various factors such as those mentioned above."
>
> "A connection from a reliable water works system, of adequate capacity and pressure, is preferable as a single or a primary supply."

"In conclusion, this thought might be expressed: Fire protection supply, of an adequacy and reliability suitable for practically any occupancy, can be provided in a municipal water works system. That it has not in every case is due in part to a lack of appreciation of the needs of such protection on the part of water works officials, which lack of appreciation is fast disappearing. The question as to whether an auxiliary supply for fire protection should be installed, involving, as it sometimes does, the further item of guarding against pollution, is one which in many cases can be answered by the strengthening of the public supply in the vicinity of the particular plant, or by the erection of an elevated tank on the property; it may also involve questions of charges for readiness to serve, or the rate at which water can be sold.

"Judging from the past, it is believed that the obligation on the part of the municipality of furnishing adequate fire protection will be so well recognized as to make auxiliary supplies unnecessary in many communities."

From this it is apparent that the way is open to water utility managers and municipal officials to secure approval by the Fire Underwriters of the complete removal of cross-connections of importance merely by providing facilities and service which may reasonably be expected by heavy local taxpayers in the nature of fire protection service and water supply. It may be that investigations will reveal that approval may be had after a relatively small expenditure for supplying water service betterments in the immediate area of the risk plant, such, for instance, as an elevated tank, or a larger or a parallel main for some relatively short distance. Perhaps the betterment may be undertaken with its financing assured through a long term contract with the plant management, somewhat after the manner now followed in financing water main extensions by several municipally operated systems.

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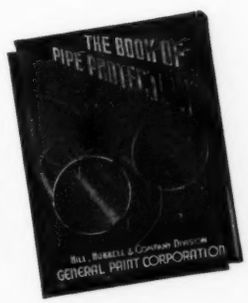

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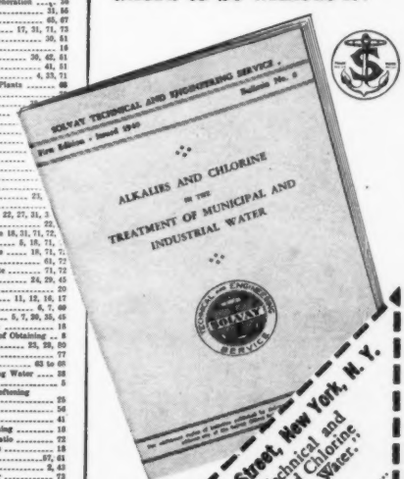

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May 22—BURLINGTON, N. J.
New Jersey Section A.W.W.A. (Luncheon and Inspection of Foundries of U. S. Pipe & Foundry and R. D. Wood Co.) Secretary, C. B. Tygert, Box 178, Newark, N. J.

May 23-24—MISSOULA, MONT. (Hotel Florence)
Montana Section A.W.W.A Sec'y-Treas., H. B. Foote, Director, Div. of Water and Sewage, State Board of Health, Helena, Mont.

May 26-28—SHEBOYGAN, WIS. (Grand Hotel)
Conference of Wisconsin Sewerage Works Operators. Sec'y-Treas., W. J. Golueke, Metropolitan Sewerage District, Green Bay, Wis.

June 16-20—LANSING, MICH. (Michigan State College)
Michigan Sewage Works Association. (Annual Meeting). Sec'y-Treas., W. F. Shepard, Michigan Dept. of Health, Lansing, Mich.

June 16-20—KANSAS CITY, MO.
American Society of Mechanical Engineers. (Semi-Annual Meeting). Secretary, C. E. Davies, 29 West 39th St., New York City.

June 19-21—NIAGARA FALLS, N. Y.
New York Sewage Works Association. (Spring Meeting). Sec'y-Treas., A. S. Bedell, State Dept. of Health, Albany, N. Y.

June 22-26—TORONTO, ONT. (Royal York Hotel)
American Water Works Association. Annual Convention. Secretary, Harry E. Jordan, 22 E. 40th St., New York, N. Y.

June 22-26—TORONTO, ONT. (Royal York Hotel)
Canadian Section A.W.W.A. (Annual Meeting). Secretary, A. E. Berry, Ontario Department of Health, Parliament Building, Toronto, Ont. (Meeting Jointly with Annual Convention of A.W.W.A.)

Aug. 7-9—ERIE, PA.
Western Penna. Section A.W.W.A. Secretary, E. P. Johnson, 418 Flannery Bldg., Sta. 13, Pittsburgh, Pa.

Sept. 1-3—STATE COLLEGE, PA. (Pa. State College)
Pennsylvania Water Works Operators' Association. Sec'y Treas., I. M. Glace, 22 South 22nd Street, Harrisburg, Pa.

Sept. 3-5—STATE COLLEGE, PA. (Pa. State College)
Pennsylvania Sewage Works Association. Sec'y-Treas., Bernard S. Bush, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 11-12—GLENS FALLS, *N. Y.* (Hotel Queensbury).
New York Section A.W.W.A. (Fall Meeting). Secy-Treas., R. K. Blanchard, Neptune Meter Co., 50 West 50th St., New York, N. Y.

Sept. 18-19—SANTE FE, NEW MEXICO (LaFonda Hotel)
Rocky Mountain Section A.W.W.A. Secretary, E. V. Howe, Sanitary Engineer, State Board of Health, Denver, Colo.

Sept. 19-20—PROVIDENCE, R. I. (Hotel Biltmore).
New England Sewage Works Association. (Annual Fall Meeting.) Sec'y-Treas., LeRoy W. VanKleeck, State Dept. of Health, Hartford, Conn.

Sept. 23-26—BOSTON, MASS. (Hotel Statler)
New England Water Works Association (Annual Convention). Secretary, Frank J. Gifford, 613 Statler Building, Boston, Mass.

Sept. 24-26—GRAND RAPIDS, MICH. (Hotel Pantlind)
Michigan Section A.W.W.A. Secretary, Maurice N. Gerardy, Department of Water Supply, Detroit, Michigan.

Oct. 9-11—MINNEAPOLIS, MINN. (Nicollet Hotel)
Minnesota Section A.W.W.A. Secretary, R. M. Finch, Wallace & Tiernan Co., Inc., 416 Flour Exchange, Minneapolis, Minn.

Oct. 9-11—NEW YORK, N. Y. (Hotel Pennsylvania)
Federation of Sewage Works Associations. Executive Secretary, W. H. Wisely, P. O. Box 18, Urbana, Ill.

Oct. 13-16—FORT WORTH, TEXAS
Southwest Section A.W.W.A. Secretary, L. A. Quigley, Supt. City Water Works, Fort Worth, Texas.

Oct. 14-17—ATLANTIC CITY, N. J. (Convention Hall)
American Public Health Association (70th Annual Meeting). Executive-Secretary, Reginald M. Atwater, M.D., American Public Health Ass'n., 1790 Broadway, New York, N. Y.

Oct. 15-17—ATLANTIC CITY, N. J. (Haddon Hall)
Pennsylvania Water Works Association. Secretary, Dr. F. Herbert Snow, 507 Telegraph Bldg., Harrisburg, Pa.

Oct. 16-18—ATLANTIC CITY, N. J.
New Jersey Section A.W.W.A. Secretary, C. B. Tygert, P. O. Box 187, Newark, N. J.

Oct. 19-22—NEW ORLEANS, LA.
American Public Works Association. Executive Director, Norman Hebden, 1313 East 60th St., Chicago, Ill.

Oct. 20-22—CEDAR RAPIDS, IOWA
Missouri Valley Section A.W.W.A. Secretary, Earl L. Waterman, Prof. of Sanitary Engineering, Univ. of Iowa, Iowa City, Ia.

Oct. 22-25—FRESNO, CALIF. (Hotel Fresno)
California Section A.W.W.A. Sec'y-Treas., G. E. Arnold, San Francisco Water Department, Millbrae, Calif.

Oct. 27-29—NASHVILLE, TENN. (Andrew Jackson Hotel)
Kentucky-Tennessee SECTION A.W.W.A. Secretary, H. D. Schmidt, Director Div. of Sanitary Engineering, Department of Health, Nashville, Tenn.

Nov. 3-5—HIGH POINT, N. C. (Sheraton Hotel)
North Carolina Section A.W.W.A. and
North Carolina Sewage Works Association. Secretary, R. S. Phillips, Box 1170, Durham, N. C.

Nov. 6-7—BALTIMORE, MD.
Four States Section A.W.W.A. Secretary, Lloyd Nelson, U. S. Pipe and Foundry, Broad and Chestnut Streets, Philadelphia, Pa.

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LITERATURE AND CATALOGS

Pumps, Compresses and Engines, by Gardner-Denver are presented in a comprehensive 48 page bulletin from Gardner-Denver Co. with a main plant at Quincy, Ill., and branch plants at Denver, Colo., and LaGrange, Mo. In looking through the new bulletin one is impressed with the variety of pumps, engines and compressors that Gardner-Denver Co. manufactures. Such includes a variety of engine driven portable compressors, many types of centrifugal pumps for water and sewage pumping, piston type pumps, pump governors, etc. We would call this a "master-bulletin" of Gardner-Denver equipment, which treats the various items briefly and is supported by individual bulletins treating the many items in more detail. For a "bird's eye view" of Gardner-Denver, request Bul. QP-10. Address Gardner-Denver Co., Quincy, Ill.

Wilson "Pulsafeeders" are presented in a new bulletin from Chemical Feeders, Inc., of Buffalo, N. Y. The "Pulsafeeder" is a positive displacement pump type of feeder. However, it has distinctive features and functions in a unique manner, involving the featured pulsating tube. The piston of the pump compresses liquid in a sealed chamber through which the resilient pulsing feed tube passes. Thereby, the tube is squeezed to form a section of Venturi tube shape and its contents (the chemical being fed) is forced out with each stroke. Check valves at both ends preclude back surging. The length of piston stroke determines the degree of squeezing of the pulsating tube. Consequently, the volume of solution pumped by the "Pulsafeeder" per unit of time (rate of feed) is a function of number and length of piston stroke. Although originally designed as a feeder for hypochlorite solutions, the "Pulsafeeder" may be used to feed any chemical solution. Six types of the interesting "Pulsafeeder" are pictured and described. For a copy of Bulletin D-41-BN, write Chemical Feeders, Inc., Buffalo, N. Y.

Valves and Hydrants, by Eddy are featured in an expensively produced catalog of 84 pages, which presents the complete line of Eddy Water Works Equipment, from Air Valves to Socket Wrenches and Valve Boxes. The Eddy Taper Seat Double Disc Gate Valves and Rubber Faced Fire Hydrants, with the swivel head, are the featured items of course. But, in addition, there are many items for water and sewage plants which Eddy offers that are not so generally known. In the rear of the catalog is a 14 page section containing much useful information of a reference nature for engineers and operators. It's worth having. For a copy write The Eddy Valve Co., Waterford, N. Y.

Flame Traps and Relief Valves are the subject of a new 16 page illustrated bulletin from Pacific Flush Tank Co., which relates the development of P.F.T. safety equipment in gas utilization at sewage plants. Typical sewage plant boiler room installations are pictured and drawings and cut-away views clearly show the design and construction and explain the operation of Flame Traps and P.F.T. automatic Waste Gas Pressure Relief Valves. Sketches of typical boiler room layouts are presented in the bulletin and also shown are P.F.T. Waste Gas Burners, Condensate Drip

Traps and other boiler room accessory equipment. New tables are included to aid engineers in determining the correct size of unit required. This bulletin (No. 121 A) is available on request. Just write "P.F.T.," 4241 Ravenswood Ave., Chicago.

"More Gallons—Less Cost" is the caption of a new Allis-Chalmers bulletin featuring the A.-C. Type S. Centrifugals, with double-suction, designed for broad application. The 40 page illustrated bulletin presents construction features, dimensions, normal and special application data. The last is told by pictures and facts, revealing worthwhile pumping savings in the water supply and sewage disposal field. In the second half of the new bulletin is given directions for figuring pumping heads, tables of rules and constants for use in head-capacity computations, friction tables and complete head-capacity tables from 30 to 7000 g.p.m. against total heads from 10 to 210 ft. The table lists a Type S. centrifugal for every practical combination of head and capacity. For Bul. B-6146 (a pump for every service) write, Allis-Chalmers (Pump Div.), Milwaukee, Wis.

Lot of Compressor in a Small Package is the theme of a new bulletin describing Schramm's Model 20 compressor which appears to be nothing more than a streamlined engine block with an attached gasoline tank, available on skids or pneumatic tired wheels. The engine consists of four cylinders—two being power cylinders (the drive) and two being compression cylinders supplying an air delivery of 20 cu. ft. per min. (displacement of 30 cu. ft.) at 100 lbs. pressure for general use. This little "package" can be moved about the shop, hooked to the rear of an automobile or truck, or placed in a truck for quick dispatch to do emergency repair work. Needless to add a "tool-box" compressor of this capacity has manifold uses in water and sewage system operation. For a detailed description and price list write for Bul. 4120—Schramm, Inc., West Chester, Pa.

"Sea-Ro" Packings and Pump Valves are presented in a handsomely done spiral bound catalog of 63 pages giving specifications, and replete with pictures of the complete line of "Sea-Ro" packings, gasket sheeting, pump valves, etc., produced by the Sea-Ro Packing Co. of Wood-Ridge, N. J. A new packing introduced recently is the Armored "Nek-Seal" Packing for centrifugal pumps as well as valve rods and stems. The feature of the "Nek-Seal" type of packing is its self contained flexible metallic sealing element. Anyone responsible for purchase and use of packing will be impressed with the new "Sea-Ro" catalog and should write for it. Address The Sea-Ro Packing Co., Inc., Wood-Ridge, N. J., or 75 West St., New York City.

Cathodic Protection by the "Rustop" System is the subject of two folders received from Electro Rust-Proofing Co. One contains a general description of the cathodic method of stopping corrosion of steel standpipes, tanks, etc., with citing of cost data and testimonials by users. Also a comprehensive list of installations is given. The second folder contains a reproduction of the report covering investigations of the "Rustop" System by the Associated Factory Mutual Fire Insurance Companies, installed on tanks of member companies. This report concludes with an approval of cathodic protection for water tanks supplying fire service water to Factory Mutual plants. For the enlightening and reassuring "F. M." report write Electro Rust-Proofing Co., Dayton, Ohio.

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FERRIC CHLORIDE

Working with you for America

● SLUDGE CONDITIONING
● SEWAGE COAGULATION
● WATER PURIFICATION

35-47% SOLUTION
Shipped in Tank Cars

60% CRYSTALS
Packed in 300 or 500 lb. Barrels

THE DOW CHEMICAL COMPANY
MIDLAND MICHIGAN

Wabash DOUBLE LID
METER BOX
Covers

Wabash Covers are designed to provide maximum frost protection for water meter settings. All sizes are 9½" in depth, have inner lids, and are provided with Lifter Locks and forged Everdur bolts. Made for 15", 18", 20" and 21" tile.

Send for catalog and complete information

FORD METER BOX CO.
SETTING AND TESTING EQUIPMENT FOR WATER METERS
WABASH, INDIANA

WHAT EVERY FILTER PLANT SUPERINTENDENT SHOULD KNOW ABOUT

Activated and Blackalum

1. Question: What is ACTIVATED ALUM?

Answer: It is a most effective coagulant, containing 7% of acid-treated insoluble clay which provides a vehicle for distributing the alumina and acts as a physical nucleus for rapid floc formation —particularly in waters of low turbidity. (Activated exceeds A. W. W. A. Alum Specifications.)

2. Q. What is DUSTLESS BLACKALUM?

A. It is Activated Alum, containing from 3% to 4% of powdered activated carbon with a phenol value of less than 25. It is quick-floc-forming, dustless, flexible, economical, and *possesses the remarkable ability to stabilize sludge, reduce chlorine demand and reduce taste and odors.*

3. Q. Why should I insist on ACTIVATED or BLACKALUM?

A. Because, only with ACTIVATED can you get ACTIVATED'S RESULTS. These products are the result of painstaking research and development — *a combination which is giving water-treatment plants more and more efficient coagulation at lower and lower cost.*

4. Q. What about PRICE?

A. ACTIVATED ALUM is sold within the very narrow limits of current market quotations for regular filter alums, while BLACKALUM, due to its activated carbon content, is only two dollars more per ton than STANDARD ACTIVATED ALUM.

5. Q. What should I do NOW?

A. Send your next order to us—then watch us perform for you.

Activated Alum Corp.

Office: 5701 Pennington Ave., Baltimore, Md.

***Works:* Curtis Bay, Baltimore, Md.**

LARGEST PRODUCTION FACILITIES

of any Cast Iron Pipe foundry in America. Daily capacity more than 40,000 feet.

LARGEST CENTRIFUGAL PIPE

of any Cast Iron Pipe foundry in America. Complete line of sizes, including 48-inch.

BROADEST SELECTION OF JOINTS

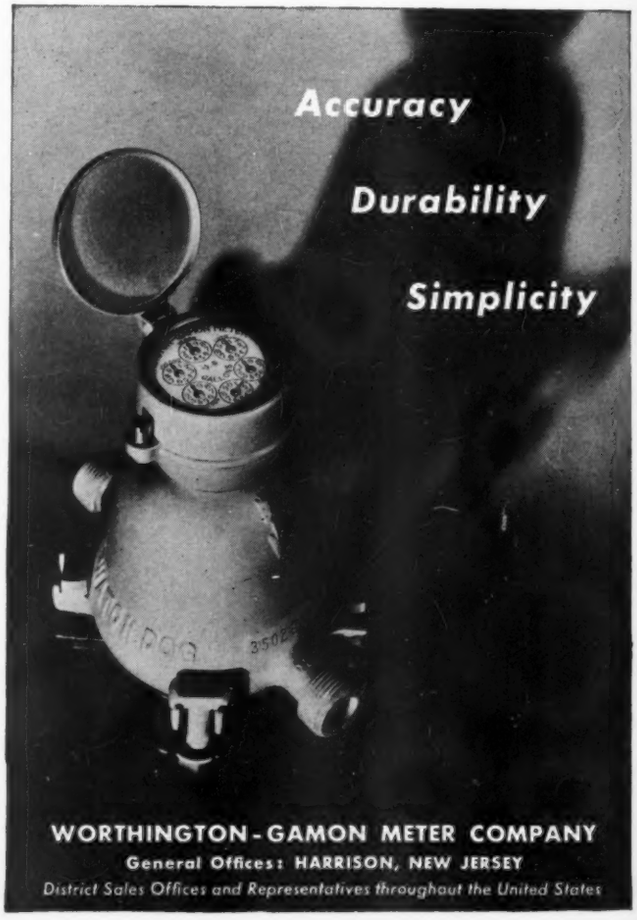
for special services of any Cast Iron Pipe foundry in America. "Acipco" has pioneered in developing Cast Iron Pipe for fields of super-service.

Whatever your piping problem, refer it to "Acipco" and rest assured of conscientious assistance from an organization backed by 36 years of experience in producing highest-quality Cast Iron Pipe and Fittings. Address "Acipco" office nearest you.

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM, ALA.

New York City Chicago Minneapolis Kansas City
Pittsburgh Cleveland Dallas Los Angeles San Francisco



WORTHINGTON-GAMON METER COMPANY

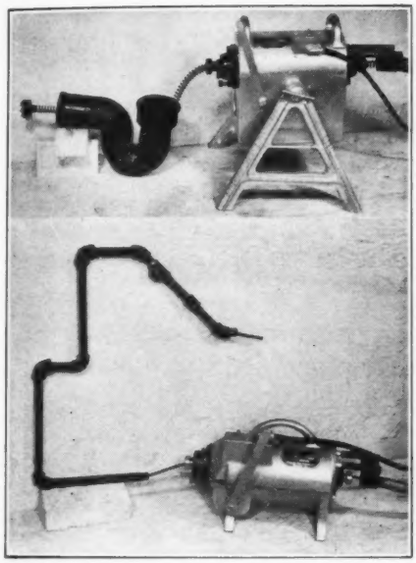
General Offices: HARRISON, NEW JERSEY

District Sales Offices and Representatives throughout the United States

EQUIPMENT NEWS

Interesting Pipe Cleaning Machine

• While it is realized that Pittsburgh Pipe Cleaning Machines are not new, they have never been accorded space in these columns and will therefore be new to many of our readers. These machines are particularly useful in cleaning small diameter pipes, consumer service lines, main extensions, condenser tubes, boiler tubes, drain lines and sewers.



Using suitable sizes of flexible spring-steel cables and cutting head-attachments rotated by the electric drive machines, lines from ½ inch to 6 inch diameter may be cleared of any form of deposit. Perhaps the most interesting feature of these machines is their adaptability to operation through bends, elbows, and even through S bends.

Pittsburgh Pipe Cleaning Machines are offered in several models, the smallest 45 lb. model being for pipes of ⅜ inch to 2 inches, and the heaviest duty 170 lb. model being for ¾ inch to 6 inch pipes.

This cleaning equipment is described in some detail in a new bulletin, which contains suggested equipment for use with the several machines and also gives a list of water companies and others using these cleaners. For a copy of Bulletin 411 write Pittsburgh Pipe Cleaning Co., 1016 Suismon St., Pittsburgh, Penna.

Don't Destroy Sludge

-It's Valuable!

You wouldn't bury a load of scrap iron or burn bales of scrap paper. Then why destroy sewage sludge for it, too, can be readily converted into a valuable product that has a ready market.

Sewage treatment plant officials or engineers the country over are fast awakening to the profit possibilities in sludge.

Properly prepared for use, sludge brings a good price. If you incinerate, bury or otherwise destroy sludge, it will cost money to do so besides the profit you lose by not selling it.

A Royer Sewage Sludge Disintegrator shreds, mixes, aerates and further dries sludge cake. It will handle sludge with a moisture content up to 51%. It is shovelled into the machine lumpy and comes out in pea size particles that are easy to spread on lawns, shrubs and gardens—particles that quickly yield their abundance of rich plant foods.

Parks, cemeteries, golf clubs, florists, orchardists and truck gardeners welcome the opportunity to buy what they know from experience is a first rate soil builder—shredded sewage sludge. Why pass up this opportunity to eliminate a cost and make a profit?

THE ROYER

Send for Bulletin 140—it shows the 12 electric, gasoline and belt-to-tractor driven models priced from $250.00 up.

ROYER FOUNDRY & MACHINE CO.
170 PRINGLE ST., KINGSTON, PA.

When You Specify

Meters and Recorders

Be Sure To Demand

•ACCURACY •RELIABILITY
•SOUND ENGINEERING
•MODERN APPEARANCE

Regardless of whether your problem calls for the use of a Venturi Tube, Weir, or Flume, you can depend on Bailey Meter Company to design and construct both the primary element and the register for maximum accuracy.

A vast amount of experience gained from thousands of installations of metering equipment, together with extensive experimental work in our own hydraulic laboratory and in the laboratories of the Ohio State University, Cornell University, Case School of Applied Science and other institutions, is back of every Bailey Primary Element.

The reliability of Bailey Meters and Recorders is attested to by the fact that thousands of dollars worth of steam and water are sold monthly and billed solely on the basis of readings from Bailey Meters.

No small share of the accuracy and reliability of Bailey Meters is due to the conservative engineering policy of the Company. New ideas and designs are not offered for sale until they have been thoroughly tested both in the laboratory and in actual service.

Bailey Meters, Recorders and Controllers present a thoroughly modern yet conservative appearance.

Write for your copy of Bulletins No. 301 and 302, describing Bailey Fluid Meters for steam, liquids, gases, sewage, sludge, and compressed air.

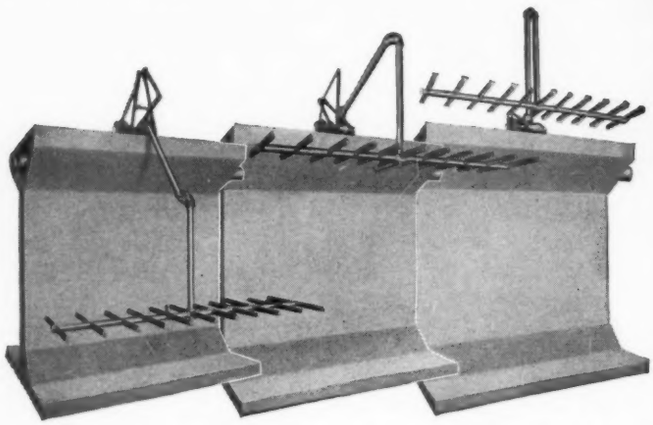
MU-16

BAILEY METER • COMPANY •

1072 Ivanhoe Road, Cleveland, Ohio

BAILEY METER COMPANY LTD., MONTREAL

Unique Improvement in Chicago Swing Diffusers



• Improvements in the "Chicago" Swing Diffuser make every part of the air diffusion unit accessible from the tank walk. To this end, each unit can be removed completely from the aeration tank by means of an electric hoist. Tube inspection, maintenance and regulation of air supply can all be accomplished from the tank walk without dewatering the tank or interrupting operation.

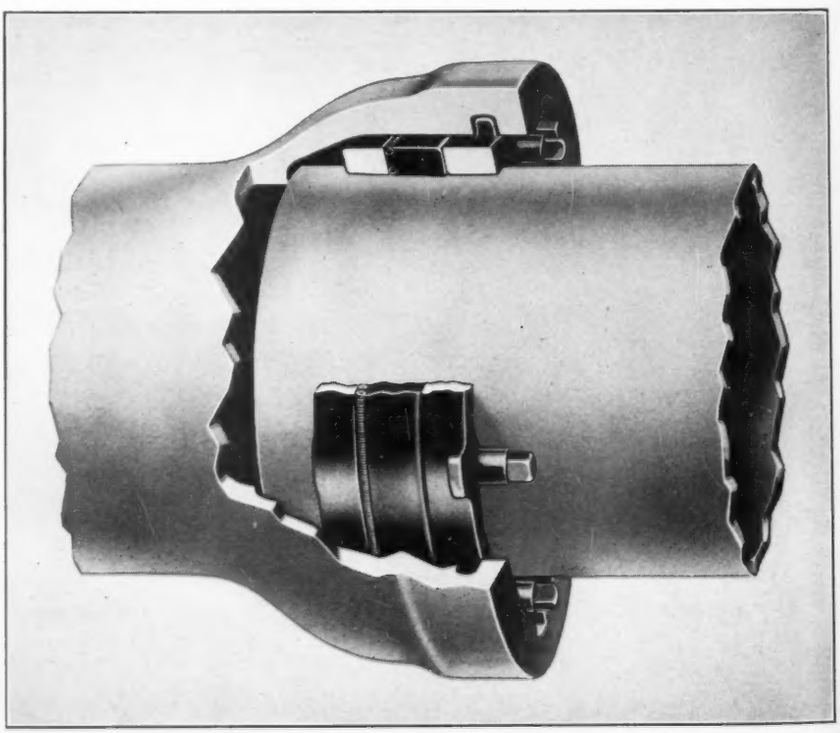
Simplified construction makes the new model lighter in weight and easier to handle. There are two joints in the new model. A swing joint is mounted in the coping at the tank walk, and a knee joint connects the two sections of the hanger pipe. The hoist grips the upper section of the hanger pipe just below the swing joint and raises the unit to the tank walk similar to raising one's leg with his knee joint relaxed. This action is illustrtaed in the cut.

The "Chicago" Swing Diffuser was designed to enhance application of the Tapered Aeration principle in the Activated Sludge Process, supplying oxygen to the mixed liquor in practical proportion to the oxygen utilization characteristics of the liquor. However, it has other advantageous applications, such as in chemical mixing, for grease separation by the aero-chlorination method, the aeration of water, and recarbonation.

For further details, write Chicago Pump Co., Chicago, Ill.

New Dresser Bellmaster Joint

• In answer to a need for a simpler and easier-to-install mechanical joint, one that will last as long as the cast-iron pipe on which it is used, the new Dresser Bellmaster Joint, Style 85, was developed. This new joint possesses a number of installation advantages and construction features not found in other



types of joints. Low in first cost, faster and easier to install, the "Bellmaster" is said to be a great advance in cast-iron pipe jointing.

The Bellmaster Joint is a single-gasketed, self-contained mechanical joint that is strong, flexible, corrosion-proof. It consists of a few simple parts—Inner Ring, Armored Gasket, Outer Ring, a set of Capscrews—all factory assembled into a single unit. To install, the Bellmaster is simply inserted in the bell end of pipe prepared to accommodate the joint, locked in place by twisting slightly clockwise, spigot end "stabbed in," and capscrews tightened. Working principle is simple and effective: as you tighten the capscrews, the inner ring is drawn closer to the locked outer ring, thus expanding the armored gasket against the outside of the spigot and against the inside of the bell, making a tight seal against both.

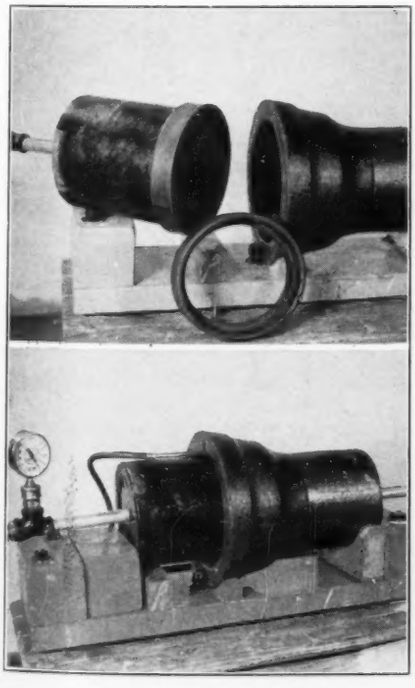
The Bellmaster's outstanding characteristic is its extreme simplicity. It comes completely assembled, and is available for pipe sizes of 4 to 16 inches, inclusive. Other sizes are in the making, according to the manufacturer. Workmen have only one piece to handle when making up the joint. All that is needed in addition is a small ratchet wrench, no other tools being required.

Dresser has issued a new bulletin which effectively describes the Bellmaster and pictures reveal its distinctive advantages.

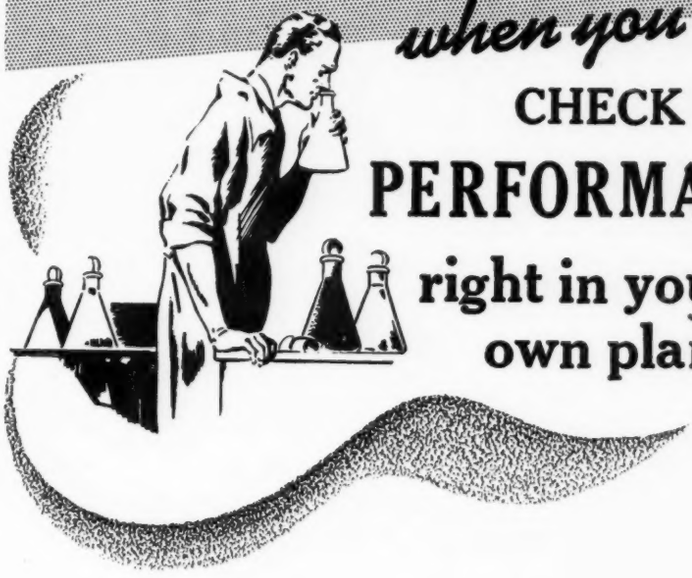
For a copy of Form 413A, write the Dresser Mfg. Co., Bradford, Pa.

Ingenious Rubber Joint Ring

• An interesting development in rubber joint packing is the invention of Mr. Thomas Miller, Superintendent of Water Works at Rome, N. Y. It has recently been placed on the market by the Water and Sewer Equipment Com-



You Need Never
RELY on CLAIMS
when you can
CHECK
PERFORMANCE
right in your own plant!



THE Threshold Odor Test, the Carbon Feed Chart, and the Darcograph—with these three methods you can determine the truth about carbon performance!

You can pick the best carbon for your plant. You can check the uniformity of each shipment, and compare the effectiveness of different methods of application.

Write for full information—and for a sample of Hydrodarco. Test it—prove that it gives maximum palatability control per dollar.

★ HYDRODARCO

To protect against sifting, the bag is sealed and taped with Latex tape

*Hydrodarco Reg. U. S. Pat. Off.

DARCO

DARCO CORPORATION

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Do you pack with flax?

Here's a tip to engineers who have been packing water pumps with flax . . .

and find the supply running low because of the war.

. . . Use PALCO* the cotton packing specially lubricated for water service with lubricant impregnated in every strand

FREE WORKING SAMPLE OF PALCO*

If you are having trouble with packing on any service, give your packings a real test . . . without cost. Send us your name and address for free working sample, stating the size and service.

* SQUARE PALCO REG. TRADE MARK PLAITED PACKING for Water

Made by the manufacturers of *PALMETTO

a Reg. U.S. Pat. Off.

Send the coupon for free sample

GREENE, TWEED & CO., Bronx Blvd. at 238 St., New York City

Send free working sample of packing..... size, for.....service.

Name .....

Company .....

Address .....

pany of Rome, under the name of "Bone-Dry" Packing Rings.

In brief, this packing ring is a deflated inner tube with a lip around one side and on the opposite an inflating valve. The above pictures show how it is slipped on the pipe spigot before inserting into the bell—then how with a small hand tire-pump this ring is inflated to make a 100 per cent seal. Disconnecting the pump from the valve and pouring the joint compound, or lead, completes the job. With this jointing material behind it and water pressure on the interior face, one can see that the inflated rubber presses the tighter against the bell and spigot walls as water pressure increases, thus forcing the tube walls into every irregularity of the surfaces of the bell and spigot.

An interesting feature of the smooth inflated tube joint is its regularity of all surfaces as well as "fluidity" (above mentioned), and the automatic centering of the spigot in the bell when fully inflated. These advantages in pouring joints, plus the realization of a packed joint which can not leak a drop during pouring, are stressed by the inventor.

All of the above are in addition to the sanitary advantages of non-bacteria breeding rubber packed joints, which add flexibility to pipe lines, save labor, reduce construction time and costs, eliminate bell holes, cushion shock, and retard electrolysis.

"Bone-Dry" Packing Rings are now available for pipes 4 inches to 12 inches in diameter (inclusive), and will be in larger sizes later. As to cost, the inventor states that the overall out-of-pocket cost of using "Bone-Dry" Rings is even less than that of the old methods, not to mention their worth in terms of intangibles.

For an illustrated booklet further describing "Bone-Dry" Pneumatic Rings, write The Water and Sewer Equipment Co., (P. O. Box 333), Rome, N. Y.

New Water Sewage and Sludge Sampler

● In the sewage field an operator's invention of interest is the "P-G" Sampler for taking truly representative sludge or sewage samples from digesters, tanks or channels. The new sampler is the invention of Chester F. Proudman, Sup't. of Sewerage at New Canaan, Conn., and Henry Goossen, jointly—thus the name "P-G."

The new sample consists of a ruggedly constructed chamber of steel, equipped with a wide opening bottom valve operated by a pull cord. Lowered into digester or tank to the desired depth, indicated on marked lowering chain, the valve cord is pulled and chamber fills. The rate of filling may be adjusted to that desired by regulating the air release valve at the top. Because the intake valve is self aligning, the closure is positive in sludge as well as liquid. The valves have been perfected so as to function as well at 30

(Continued next page)

ROUGH ON RUST!

The Rusta-Restor Method of Tank Protection

There's no percentage in letting rust accumulate on your water tanks and filter beds. **Get rid of it electrically**—and **stay** rid of it, **by electricity**—the only known means of POSITIVE PREVENTION:

RUSTA-RESTOR TRADE MARK REGISTERED

Circular on request

RUSTA RESTOR CORPORATION

1480 W. State St. Fremont, Ohio

HYDRO-TITE

A DEPENDABLE self-caulking joint compound used to joint cast iron bell and spigot pipe. Much easier to use than lead and makes stronger, more flexible and tighter joints.

Employed on thousands of miles of pipe from 4" to 60". Write for our free trial offer.

HYDRAULIC DEVELOPMENT CORPORATION

MAIN SALES OFFICE - 50 CHURCH STREET, NEW YORK
GENERAL OFFICES AND WORKS - WEST MEDFORD STATION BOSTON, MASS.

OVER 25 YEARS WITHOUT A FAILURE

feet as at 5 feet submergence. Its most distinctive feature is that it is "foolproof."

Besides the numerous uses of the "P-G" Sampler as a guide in routine operations, and for investigations at

sewage plants, this device is useful in sampling water bodies, bottom muds, and for taking samples of flocculated water from basins, or studying sludge depositions; also, for taking representative samples of sand from filters undergoing washing. It is reasonably priced.

For further information as to details and price, write Proudman and Goossen, White Oak Shade, New Canaan, Conn.

The "Test-A-Tone," a Sensitive Water Leak Detector

• The "Test-a-Tone," the newest thing in instruments for detecting and tracing water leaks, has just been announced by Joseph G. Pollard Co. of New York.

The "Test-a-Tone" is something of a super stethoscope for trouble finding in general, by magnification of vibrations and machinery, clicks or knocks. It was, in fact, developed for use by mechanics and engineers listening for and locating foreign noises in compressors, engines, and machines of various sorts. Its application as an extremely sensitive and selective instrument for detection of vibrations set up on pipe lines, fire hydrants, etc., by high velocity water leaks through joints, fittings, etc., has proven its worth to water

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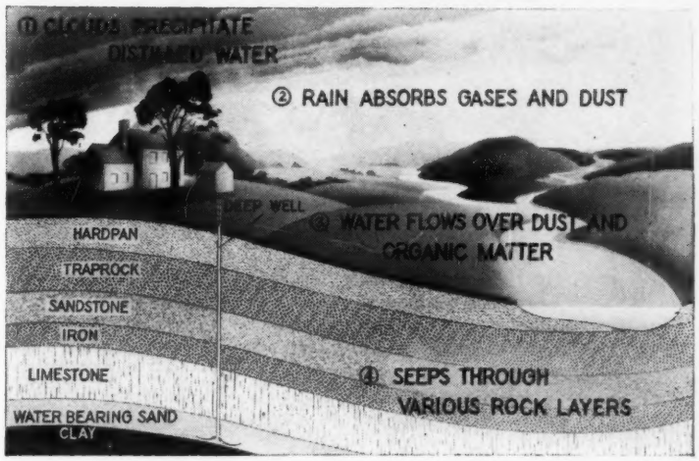
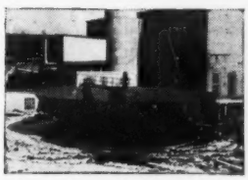
Here's how Nature makes water HARD



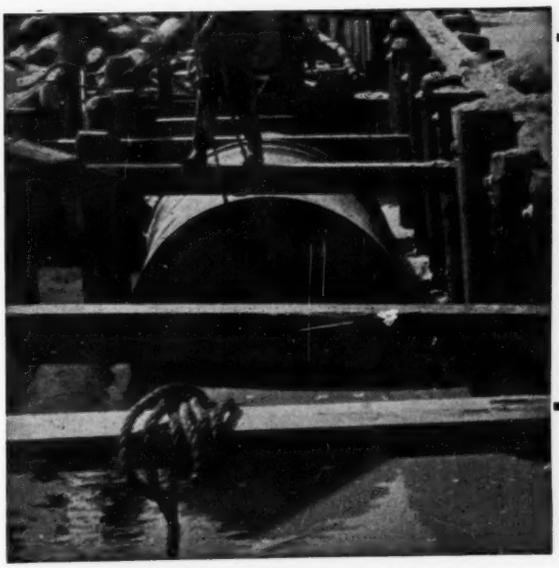
and here's how PERMUTIT* makes it SOFT and CLEAR again for modern municipalities

Permutit's Spaulding Precipitator puts soft, sparkling water within reach of every community. This new cold lime process takes half the space of old design plants, makes new economies. Free booklet on any water conditioning process from The Permutit Company, Dept. G1, 330 West 42nd Street, New York, N. Y.



**Trademark Reg. U. S. Pat. Off.*

PERMUTIT WATER CONDITIONING HEADQUARTERS



84" pipe—Spring Lake, N. J.

FLANGED PIPE

FLEXIBLE JOINT PIPE

BELL & SPIGOT PIPE

SPECIAL CASTINGS

SHORT BODY BELL & SPIGOT SPECIALS

Large stock enables us to make prompt shipments.

CAST IRON PIPE

SIZES 2" TO 84"

Warren Foundry & Pipe Corp.

11 Broadway, New York

Warren Pipe Company of Mass., Inc.

75 Federal St., Boston

works and sewerage operators for this purpose as for others.

A feature of particular interest, in addition to the sensitivity boosting element, is the adjustment screw for volume control and selectivity. The latter is important in damping out extraneous background noises. It, however, is extremely simple and compact, no electric batteries being involved, and comes in the neat carry case. The rods are adjustable in length and one, for softening the sound if too great, is rubber tipped.

For more detailed description, and pictures showing its use for checking bearings and valves as well as water leaks, write the Joseph G. Pollard Co., Inc., 142 Ashland Place, Brooklyn, New York.

"Airflex," a New Coupling

● A new type of flexible coupling, the "Airflex," has been perfected by the Falk Corp. of Milwaukee.

This coupling is especially designed for connecting Diesel, gasoline, or gas engines to any type of driven machinery. The degree of resiliency can be readily changed to suit the exact requirements of a particular application. And it decreases peak torque values when either the prime mover or driven equipment has a high fluctuating torque characteristic.

The "Airflex" Coupling consists of a special resilient rubber gland lined with a pre-moulded and pre-vulcanized cylindrical section, especially treated to prevent air loss. The entire gland is permanently bonded to rugged steel inner and outer rims, and is inflated to proper pressure through a specially designed standard threaded Schrader valve.

The degree of elasticity in this coupling is varied by changing the air pressure. This frequently eliminates the necessity for adjusting the setting of the connected units, or making changes in shaft diameters, bearings, etc., to alter the torsional characteristics of the drive system.

Falk Airflex Couplings are made in six standard types, so that the type best suited to the requirement can be

(Continued next page)

Is your Pump a Dud in the Mud ?

Does your pump choke up when it has to pump thick, muddy water or sludge? Do you have delays caused by men taking apart your pump for cleaning?

REPLACE IT WITH A HOMELITE

35% solids without clogging—that's what a 93-pound Homelite Portable Pump will handle. Its patented non-clog body passes the thick with the thin. It has no pockets to accumulate mud. And it's self-cleaning. It's always working. Never causes cleaning delays. Keeps your worker on more important work.

15,000 gallons per hour—that's how much a Homelite will pump. And it has a 28-foot suction lift. Is fast self-priming. Keeps seepage constantly at strainer level. It's the most effective pump you can buy for the money—a rugged gasoline-engine-driven pump that keeps labor and maintenance costs right down to rock bottom.

Send for our complete pump bulletin

HOMELITE CORPORATION

2505 Riverdale Ave., Port Chester, N. Y.

Know any other JOINTING COMPOUND THAT CAN MATCH THIS?

In a test to see what *Tegul*-MINERALEAD Joints could really stand, we rigged a power hammer carrying a 50-lb. iron "head" and actuated by a cam. In fifteen hours this device rained 90,000 smashing impacts on two 12' lengths of 4" pipe jointed with *Tegul*-MINERALEAD and forming a span 19' between supports ● 90 lbs. water pressure was maintained in the pipe, and, at the end of this tough test, there wasn't even a sign of a leak ● *Your* pipes will never have to take such punishment, but, jointed with *Tegul-MINERALEAD*, they'll take everything that comes their way ● Write for more information about the many advantages of this sulphur-base, quick-sealing jointing compound which comes in ingot form ● The Atlas Mineral Products Company of Pennsylvania, Mertztown, Penna.

Tegul- MINERALEAD

for Jointing BELL & SPIGOT PIPE

AER-O-MIX AERATOR—MIXER

Down-Draft Type MECHANICAL SEWAGE AERATORS

Write for information on AER-O-MIX for your SEWAGE or WATER TREATMENT APPLICATION.

VOGT MFG. CO.
INCORPORATED
P. O. Box 1122 Louisville, Ky.

applied with the minimum of special work. One type is a disconnecting coupling for dual drives, and other requirements where a quick disconnecting coupling is required.

For illustrated details concerning the six types of the new "Airflex" Coupling write The Falk Corporation, Milwaukee, Wis.

Micro-Action Valve for Governors and Gauges

• For dampening the pulsation of boiler plant pump governors and to eliminate "jitters" of gauge hands in general, a novel device known as the Campbell Micro-Bean has been developed. It can be installed on the pressure line to the diaphragm of a pump governor for protection of the pressure gauge mechanism and tube, also the spring, diaphragm and stem packing. It is also effective as protection to any control valve, such as a back pressure or reducing regulator and for use with sensitive control instruments and gauges subjected to pulsating flow or pressure vibrations.

The Micro-Bean valve will handle steam, fuel oil, gas, water or other liquids, with simple adjustment for each viscosity. It consists of a solid brass body in which a filter is inserted to prevent foreign matter from reaching the valve proper. The valve has extremely slight taper so that very sensitive control of the shut-off is effected.

This dampening device is universal in application for varied purposes up to 3,000 pounds pressure, and will give any degree of stabilization desired by merely adjusting the valve.

For descriptive literature, write the J. A. Campbell Co., 645 East Wardlow Road, Long Beach, Calif.

Now an All-Glass Pump for Small Installations

• Some months ago the availability of an absolutely non-corrodible centrifugal pump offered by Nash Engineering Co. of South Norwalk, Conn., was described and pictured in these columns.

These pumps, constructed throughout of heavy walled glass, except for the outside protective case of metal, represents a joint development by Corning Glass Works, and Nash.

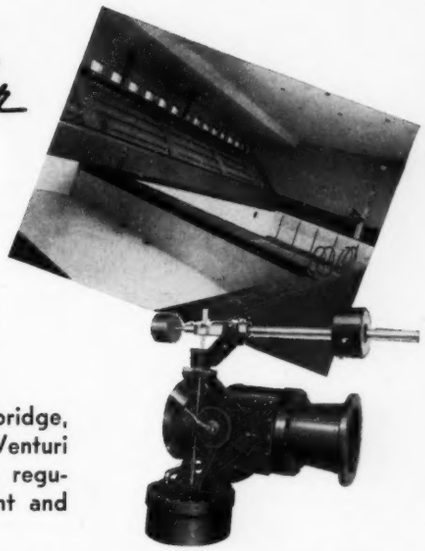
Having proved a practical success, a demand for this glass pump in smaller sizes has resulted in the production of a ¾ inch x 1 inch pump, the capacity of which is 10 gallons per minute.

This smaller unit would seem ideal for handling ferric chloride, saturated salt brine, chlorine water, or other corrosive liquids now employed in water, sewage and industrial waste treatment.

For an illustrated description in more detail, write Nash Engineering Co., South Norwalk, Conn.

BUILDERS Controller

FOR FILTER EFFLUENT AND BACKWASH CONTROL



At the new ultra-modern Swimming Pool at Massachusetts Institute of Technology, Cambridge, Mass., a single Type E Venturi Controller automatically regulates both filter effluent and backwash flow.

For new filters or remodeling old filters you'll want a copy of Bulletin 321. Address:

Illustration shows Swimming Pool at Massachusetts Institute of Technology, Cambridge, Mass. Designed by Anderson & Beckwith, Architects, Cambridge.

BUILDERS . PROVIDENCE
IRON FOUNDRY RHODE ISLAND

· SCHRAMM ·
AIR
COMPRESSORS

105 c. f. m. actual air delivery compressor — Streamline tool boxes. Easily transported from job to job.

THE MODERN TOOL FOR EVERY WATER AND SEWER DEPARTMENT

1 PAVING BREAKING: The SCHRAMM 105 compressor, illustrated will operate two of the heavy duty type paving breakers, breaks up concrete, asphalt or other tough material.

2 CLAY SPADE OR TRENCH DIGGER: For emergency work where speed is an essential factor, the trailer type SCHRAMM compressor can be quickly hauled right up to the job.

3 ROCK DRILLING: A very essential part of all excavating work can be just as easily handled with this compressor regardless of depth requirements. For light drilling this compressor will operate two of our model H-66 drills.

4 SHEET PILE DRIVING: So necessary to operators where materials have a tendency to slide. Again the 105' SCHRAMM compressor is recommended for handling two breakers with a sheeting driver attachment.

5 CAULKING PIPE JOINTS: The SCHRAMM 105 compressor ready at a moment's notice to repair breaks in pipe line. Ample air supply to operate gate closing mechanism when an emergency arises.

6 BACKFILL TAMPING: Is now a part of most specifications where pavement is to be laid over the fill because ramming is solid, even and tight.

SCHRAMM Portable Compressors are built in sizes ranging from 20 to 420 cu. ft., for gasoline or diesel engine drive—rubber tired, two wheel trailer type or for truck mounting. Write for bulletin No. 3900.

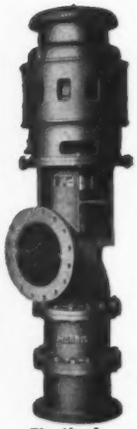
SCHRAMM, inc.
WEST CHESTER PA

The MORRIS HYDRAULIC COLUMN

News of interest to Centrifugal Pump Users

Vertical Mixed Flow Pump

Horizontally Split Case Double Suction Water Supply Pump



Vertical "Straightflo" Pump

An exactly suitable centrifugal pump for every municipal service

Complete Line. Whether you want a pump for water supply, sewage, storm water drainage, fire protection, condenser circulation, boiler feed, or general service, you can get it from Morris.

High Efficiencies. Morris pumps are notable for their high efficiencies—frequently exceeding 90% in favorable operating conditions.

Long Life. Many Morris installations are still in service after 30 years, 35 years, and longer—convincing evidence of trouble-free design and sturdy construction.

Authoritative Recommendations. Back of each Morris design are 76 years of experience in building centrifugal pumps. You are safe when you specify Morris.

Write for Bulletin

MEMBER

For authoritative recommendations on any pumping or dredging problem, write to Morris Machine Works, Baldwinsville, N. Y. Representatives in principal localities. *Export Office*, 50 Church St., New York.

New Unitilt Bulldozer

By Buckeye

● The Buckeye Traction Ditcher Co. of Findlay, Ohio, announces the development of new Buckeye UNITILT Cable Controlled Bulldozers and Trailbuilders for all makes and models of tractors. The name of the new design is derived from the patented tilting device and the *universality* of the frame, which permits using either Buckeye Bulldozer or Trailbuilder moldboards on the same frame. This latter feature eliminates the original investment in two frames in order to have both Bulldozer and Trailbuilder and further simplifies changing over. One man can change moldboards, which can be dismounted from the tractor by pulling two kingpins. The sidearms and other parts stay in place.

The tilting device is located on one sidearm and permits raising or lowering Bulldozer or Trailbuilder blade at either end a distance of 12 inches. Turning one bolt only is all that is required to effect the tilting adjustment.

Other features of the new design include: construction of the front cross beam so that the blades hug the radiator, thus reducing the heavy overhanging load on the front of the tractor and reducing wear on front idlers and track rolls; blade curvature which *rolls* the dirt ahead, reducing "dead" weight and permitting bigger loads in front of the blade; 60-inch lift of blade and unlimited depth of cut below ground level; natural digging action of blade which cuts as deep as operator desires without requiring any mechanical means of creating down pressure; balanced design which prevents tipping of tractor and keeps full length of crawlers on the ground; sidearms mounted at drive axle of tractor; rigid, fully braced members to withstand all types of 'dozing work.

For literature and specifications on UNITILT equipment, write Buckeye Traction Ditcher Co., Findlay, Ohio.

New Drill and Compressor

● A new Wagon Drill and a new small moderate priced Portable Compressor have been put on the market by Sullivan Machinery Co.

The Sullivan Wagon Drill, in three models, mounts 55 to 75 pound drills and increases drilling footage 50 to 80 per cent over hand operation. It is pneumatic tired, convenient to handle, and drills at any angle.

The new Sullivan Zephair Compressor is a compact, quality built unit. The two wheel pneumatic tired model tows conveniently behind a passenger auto at regular traffic speeds. It is built for one man handling. The skid type can be set in a pick-up truck, leaving ample room for other equipment. The Zephair compressor is built for delivering 105, 85 and 60 C.F.M.

For the Zephair Bul. A-41 or the Wagon Drill Bul. 87-T write, Sullivan Machinery Co., Michigan City, Ind.

IF Your SEWAGE effluents are high in suspended solids;

Or, you have a WATER PROBLEM;

Or, desire to RECOVER a product now wasted;

Or, you are disturbed by STREAM POLLUTION;

Or, are in any way interested in the removal of suspended solids from liquors;

You should investigate the

Laughlin Modified Rapid Sand Filter

BECAUSE, it is a simple automatic, continuous flow apparatus, designed on familiar lines, to accomplish a purpose without adding to the operator's troubles.

LAUGHLIN EQUIPMENT CORPORATION
270 Madison Ave., New York City

LEADITE

The Pioneer Self-Caulking Material for C.I. Pipe

Water Works Men Know LEADITE—
Saves caulking time, digging time, melting time, handling time and charges... and makes a good tight joint that improves with age!

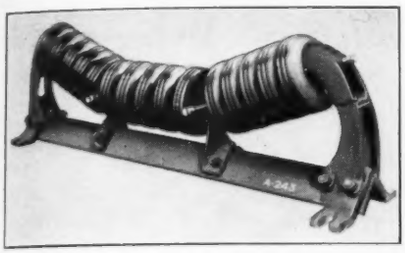
THE LEADITE COMPANY
Girard Trust Co. Bldg., Philadelphia, Pa.

No Caulking

Pneumatic Belt Rollers

• A recent development is the pneumatic roller, for carriers on belt conveyors. It is introduced by the Stephens-Adamson Manufacturing Co., makers of the well-known line of S-A Belt Conveyors and Bucket Elevators. The rollers in these new belt carriers are made up of a series of pneumatic rubber units, 6" in diameter, suggestive of miniature automobile tires. Their advantage over a solid roller has been compared to the advantage of the pneumatic tire for trucks and automobiles over the now obsolete solid rubber tire: greater resiliency to shock and impact and increased life.

The rollers in Stephens-Adamson Impact Carriers are mounted on the



steel hub in which bearings and shaft are housed. Roller units have thick, wear-resisting treads and are inflated and permanently sealed to prevent loss of air. The assembly is built for easy servicing and quick replacement of damaged units. The carriers are identified as "Style No. 711 Pneumatic Impact Carriers." For details and literature write Stephens-Adamson Mfg. Co., Aurora, Ill.

"No-Spot," a New Floor-Sweep Compound

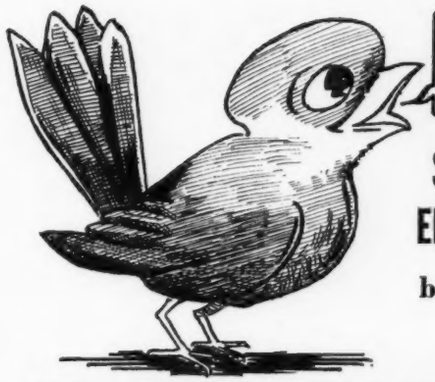
• A new floor sweeping compound of interest has been perfected for use on tile and resilient flooring in general, such as J-M Asphalt Tile, etc.

It is offered as a blended wax base compound which contains no abrasives or oil to damage or mar such floors.

For descriptive literature and prices write Frank Miller & Sons, 2250 West 58th St., Chicago.

Modern Airplane Wing Designs Applied to Peerless Pump Propellers

• The well known and readily recognized airfoil sections used in modern airplane wings are being commercially applied to deep well and propeller pumps. The airfoil principles adapted to the propeller vane sections have been thoroughly and successfully applied to deep well applications by the Peerless Pump Division of the Food Machinery corporation. The improvement in performance found by adaptation of the airfoil section to deep well impellers and bowls has been carefully observed over the past three years, during which time they have been continuously put in commercial use.



"WE CAN TAKE IT.."

So say SUPERINTENDENTS - ENGINEERS - PLANT OPERATORS

because our FIRST LINE OF DEFENSE is

FERRICHLOR

(ISCO Ferric Chloride)

FOR SLUDGE CONDITIONING

FERRICHLOR is a most efficient agent.

FOR COAGULATING SEWAGE

Treatment plants, both large and small, find FERRICHLOR to be the most effective coagulant for chemical treatment of sewage.

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THE NATIONAL METHOD

BEFORE CLEANING AFTER CLEANING

CLOGGED PIPES

Made Good as New

THE NATIONAL METHOD OF WATER MAIN CLEANING makes your old pipe practically as good as new. Every department is subject to loss through the ravages of time upon its distribution system. The cleaning out of this foreign matter inevitably leads to increased pressure and flow, improved health conditions, and lowered operating costs.

Our illustrated Booklet, "The Cleaning of Water Mains," will be sent upon request.

NATIONAL WATER MAIN CLEANING CO.

30 Church Street, New York, N. Y.

BRANCH ADDRESSES

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WATER TREATING EQUIPMENT

Gravity and Pressure Filters, Softeners, Recarbonators, Chemical Diffusers, Cooling Towers, Standard and Special Equipment for any Water Treating Problem

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Dwight Bldg., Kansas City, Mo.

ACCURATE, TROUBLE-FREE
EMCO
SEWAGE GAS METERS
IN THE MOST MODERN PLANTS

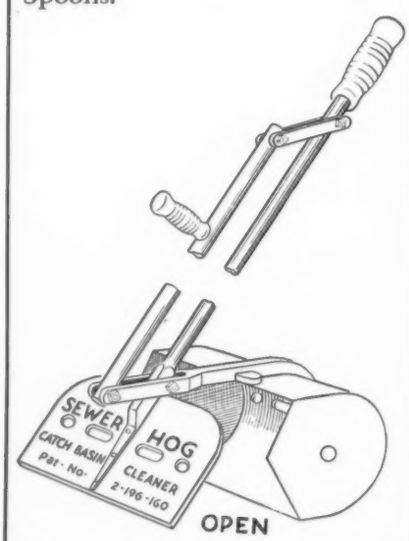
Accurate measurement of all gas generated in sewage plants is assured through the use of EMCO Pressed Steel Meters which operate by the positive diaphragm displacement method. Due to their compact design, they require less floor space than any other meter of the same rated capacity. Their sturdy construction is a safety factor important in a plant of this character.

Nordstrom Lubricated Plug Valves are specified due to their resistance to leakage and the fact that they always open or close easily. Their basic construction makes them inherently resistant to corrosion and erosion. And don't forget, in sewage disposal plants everywhere Nordstrom Valves have proven that they will outlive the average valve several times over.

PITTSBURGH EQUITABLE METER CO.
MERCO NORDSTROM VALVE CO.
410 N. LEXINGTON AVE., PITTSBURGH, PA.

"Sewer Hog"

Turbine's New Patented Catch Basin Cleaner eliminates old fashion Catch Basin Spoons.



Simple, inexpensive; pays for itself every time used.

TURBINE SEWER MACH. CO.
5210 W. State St., Milwaukee
276 Lafayette St. New York, N. Y.

WITH THE MANUFACTURERS

Manufacturers' Association Appoints Arthur Clark Secretary-Manager

Arthur Clark

● Arthur T. Clark, Morristown, N. J., has been appointed Secretary - Manager of the Water and Sewage Works Manufacturers Association, comprising a membership of 150 leading manufacturers.

Mr. Clark is a civil engineer of unusually broad experience in operation, construction and design of plants, as well as in the manufacturing and sales end of the field. He is also widely known.

After graduation from Rensselaer Polytechnic Institute with the degree of C.E. in 1907, Mr. Clark entered the consulting engineering field and, later, the operating field. Starting as a plant superintendent he eventually became Chief Engineer of the Community Water Service Co., with its numerous operating properties.

In more recent years, since the passing of the Community system to the American Water Works and Electric Co., Mr. Clark has been at various times affiliated with the National Water Main Cleaning Co., The Barrett Co., Joseph G. Pollard Co. and, until this appointment, with Pomona Pump Co. in their New York office.

The 33 year old Water Works Mfgrs. Association during the past year expanded its activities to include the rapidly growing sewage field. Now functioning under the new constitution as the Water and Sewage Works Mfgrs. Assn., the appointment of a full time Secretary-Manager was voted by the new Association. Mr. Clark is the first appointee.

Headquarters offices of the Association have been established at 22 East 40th St., New York, N. Y.

Columbia Expands Technical Service

● W. I. Galliher, director of Sales, Columbia Chemical Division, Pittsburgh Plate Glass Company, today announced the appointment of Dr. G. L. Cunningham as manager of the Technical Service Department.

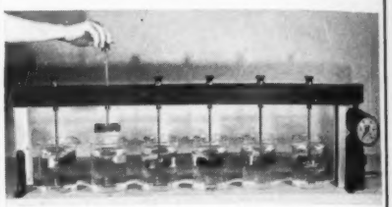
Dr. Cunningham joined Columbia last year, after having served as Research Chemist at Mathieson Alakli Works since 1930.

WACOR
WATER HAMMER ARRESTERS

● Positively Reduces Water Hammer and Protects Equipment. Write for Descriptive Bulletins.

Water Hammer Arrester Corp.
West Pierce and 12th Sts.
Milwaukee, Wisconsin

THE Phipps & Bird
LABORATORY MIXER . . .



IS the important piece of equipment in the Modern Water Works Laboratory. Now being used by leaders in water works research. Many superintendents and chemists have been able to reduce their chemical costs by the control of chemical dosages with this mixer. Write for literature.

PHIPPS & BIRD, INC. Richmond, Va.

EDSON'S NEW HAND PUMP

Smallest Diaphragm Pump Made, 2" Suction Open Discharge. Capacity 1400 G.P.H. Weight 50 lbs.

THE
EDSON CORP'N
49 "D" Street
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NEW YORK: 142 Ashland Pl., Brooklyn
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Catalog "T" Gives Full Data, Also Edson Hand and Power Pumps, Suction Hose and Pump Accessories

ANTHRAFILT
A Filter Medium For All Purposes

ANTHRACITE EQUIPMENT CORP.
19 Rector St. New York

H. G. Turner Research Engineer
STATE COLLEGE, PA.

Complete Sewer Cleaning Equipment

Before you clean your sewers, don't fail to investigate our equipment. We supply a complete line of sewer cleaning apparatus — machines, sewer rods, cleaning tools. Machines may be purchased or leased.

Sewer rods and hand tools sent on free trial.

Manufacturing Sewer Cleaning Equipment Since 1901

Write for Catalog

W. H. STEWART

Box 587 Syracuse, N. Y.

Box 581 Jacksonville, Fla.

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JOINT LEAKAGE

with CARSON

MECHANICAL JOINTS

● CHARCOAL IRON BOLTS ●

for Cast Iron Pipe and Fittings

(Also Leak Clamps)

WRITE FOR PRICES

CARSON CADILLAC COMPANY

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The Wilson Pulsafeeder

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HYPO-CHLORINATOR

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GENERAL CHEMICAL

FEEDER

Available in Manual

Semi-Automatic—Automatics

Watch for

Full Page Announcement

In June Issue

WILSON CHEMICAL FEEDERS, Inc.

Buffalo, N. Y.

For advance information write for Bulletin D-41-BN

The Langelier

MOTORIZED WATER HARDNESS APPARATUS

for the rapid and convenient determination of CaH and MgH, separately or combined. Write for details.

Chemlab Specialties Co.

52 Alvarado Road

Berkeley, California

Carl Beyer Killed in Automobile Accident

A. Carl Beyer

● A. Carl Beyer, young and brilliant manager of Wallace and Tiernan's San Francisco office, was killed in an automobile accident on April 30th. He was only 39 years old.

Born in St. Paul, Minn., June 20, 1901, he was graduated by the University of California in 1925, ranking as a top honor student in Sanitary Engineering under Professor Charles Gilman Hyde. More than just a brilliant student his popularity on the campus resulted in his election as president of the student body of the university in his senior year.

His first position (1925) was that of Ass't City Engineer of San Rafael, Calif. In 1926 he became associated with the Pelton Water Wheel Company of California. Early in 1929 he joined the San Francisco organization of Wallace and Tiernan Co. under that master salesman of exceptional personality—the late Alexander Bell. Upon the latter's death Carl Beyer succeeded to the position of manager of the San Francisco office.

Mr. Beyer was active in professional and association work. He was a member of the Am. Soc. of Civil Engrs., the American Water Works Association and the California Sewage Works Ass'n. The last he had served as an officer, and as its representative on the Sewage Works Federation Board of Control. As in his student days, all who knew Carl Beyer had a high degree of faith in, and admiration for him. He was what people like to call "a straight shooter" through and through. In his untimely death his company has lost a most valuable and highly regarded representative.

Boezinger Elected Merco-Nordstrom Vice Pres.

● H. Boezinger, for the past number of years District Manager in Los Angeles of the Pittsburgh Equitable Meter Company and the Merco Nordstrom Valve Company, has recently been elected a Vice President of Merco Nordstrom Valve Company. Mr. Boezinger is a graduate of Stanford University and has been associated with the Merco Nordstrom Valve Company for a number of years. His additional activities will cover the entire West Coast.

SERVICE WORK

—made easy!

HOW? Simply use Dresser Style 38 Service Couplings for repairing defective services or renewing mains . . . eliminate threading, exact pipe lengths, work trying to screw fittings on. All you have to do to make new connections is to cut the pipe, slide the coupling on, tighten bolts, and the job is done! Style 38 Service Coupling is permanently tight, flexible, is installed with only a wrench, takes plain-end pipe, acts as a union, and makes exact lengths of pipe unnecessary. Sizes from 3/8" ID up.

We will gladly send you a free sample on request. Just specify "Style 38" and mention pipe size.

DRESSER MANUFACTURING CO.

415 Fisher Avenue, Bradford, Pa.

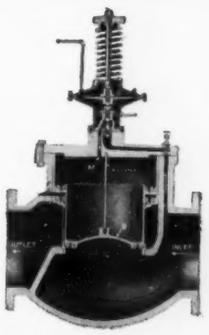
In Canada:

Dresser Mfg. Co., Ltd.

60 Front St., W., Toronto, Ont.

See page 40 of our new 96-page catalog for information on this

SINGLE ACTING STANDARD ALTITUDE VALVE



Where a separate discharge line or bypass arrangement is used for removing storage water, this valve, placed in the upstream pressure line, will maintain a uniform water level in tank, standpipe or reservoir within a range of 3" to 12" variation.

GOLDEN-ANDERSON VALVE SPECIALTY CO.

Fulton Building Pittsburgh, Pa.

GASKET AND FORM

The Perfected Method for Making SEWER PIPE JOINTS OF CEMENT

- No jute used—gasket centers spigot.
- Definite space in each joint for cement.
- Form confines cement-grout to lower portion of joint.
- Particularly advantageous in water-bearing trenches.
- Infiltration minimized.

L. A. WESTON **Adams, Mass.**

TAPAX

The ORIGINAL and FINEST....

Manhole Cushion U. S. Pat. No. 2,050,050 offers you the simplest solution for noisy, rattling covers. Easy to install. Lasting — Economical.
Write for story of Tapax and Trial Offer.

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MAMARONECK NEW YORK

PHOENIX
DISC WATER METERS
FEATURING
SPIRAL GEARS
(A Phoenix Patent)

Have an Excellent Record of Dependable — Accurate Service *Since 1914.*

Repair Parts for Water Meters
We furnish Parts for
UNION KING METERS
Send inquiries for prices.

PHOENIX METER CORP.
PRINCE BAY, S. I. NEW YORK, N. Y.

The Meter-Master
RATE RECORDER FOR
WATER METERS
Send For Literature
F. S. BRAINARD & CO.
246 Palm Street, Hartford, Conn.

New President of Crane Co. Started as Core Maker's Helper

John H. Collier

● Crane Co. Directors at a special meeting on May 5 elected Mr. John H. Collier as president to fill the vacancy created by the sudden death of Mr. Charles B. Nolte on April 29.

Mr. Collier, born in Chicago in 1884, was educated at Purdue University, and joined Crane Co. on leaving school in 1903. From his original position as core maker's helper 38 years ago he has progressed through a variety of positions giving him a very intimate and thorough grasp of the company's activities. The later and more important positions in this list are:

General Manager, Bridgeport, Conn., plant, Crane Co., 1917-1929; President, Cie Crane, Paris, France; Chairman, Crane, Ltd., London, England, 1929-1933; Vice President in Charge of Manufacturing, Crane Co., Chicago, 1933-1941.

Mr. Collier's first act as president was to issue the following statement:

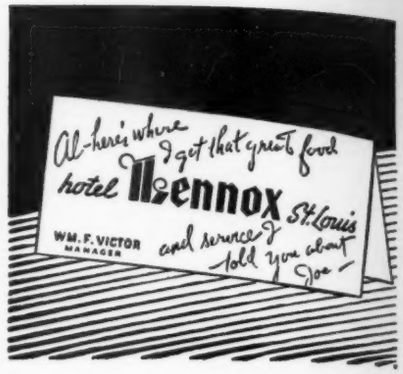
"It is a pleasure for me to know that in taking office as president of this company, its policies are sound and well established and that the organization is at a high peak of efficiency. An outstanding feature of the Crane organization has been the fine spirit of cooperation which has existed throughout. It is my intention to continue the policies which have been in effect, and it will be my endeavor to foster that spirit of cooperation to the fullest extent."

George Lewers Passes

● George R. Lewer, Chief Designing Engineer for The Underpinning and Fountain Co., died on April 7th, having failed to recover from a series of operations. He was 53 years old.

Mr. Lewers, a native of New York, City, was a graduate of Pratt Institute and Dartmouth College. He had expert experience in building chemical and metallurgical plants, which resulted in his being retained as consultant to the Russian Government on construction of important metal smelting and refining plants.

For the last 6 years of his life he had held the position of Chief Designing Engineer for the Underpinning and Foundation Company of New York, specializing in the design and installation of multi-hearth sludge and garbage incinerators and automatically cleaned sand effluent-filters for sewage plants.



You'll like the Lennox in St. Louis, too. Here in a handy downtown location, you'll find cheery, comfortable surroundings... sleep-inviting beds, famous food and drink... everything to make your stay pleasant.

All rooms have private bath and guest-controlled radio. Rates: 50% of all rooms $3.50 or less, single; $5.00 or less, double.

HOTEL **Lennox**
9th & Washington • St. Louis, Mo.
Nearby Parking and Garages

CLASSIFIED

The Borough of Media, Pennsylvania, offers for sale, at its Waterworks, the following used equipment:

1—Westinghouse Turbo Generator 100 K.W. Gen. 60 cycle, 3 ph., 2400 volts, 4 E.H. Reducing Gear. Turbine No. 3492, 7200 RPM. Generator, 125 KVA Serial 1982185.

1—twin Wetherill Corliss horizontal Double acting non-condensing engine with common crank and fly wheel, direct connected to high pressure pumps, now pumping at rate of 1,500,000 gallons per day at 140 lb. water pressure. 120 lbs. steam pressure.

1—Heine 250 HP. hand fired Boiler.

4—pressure filters, suitable for swimming pools, 8 ft. diameter by 20 ft. Now operating at pressure of 140 lbs.

POSITION WANTED

Waterworks chemist and plant superintendent, B.S. degree in chemical engineering, with a broad and mature knowledge of modern plants and treatment practices gained through more than twenty years of wide experiences, seeks new connections, preferably in plant operation and management. Box 58, WATER WORKS & SEWERAGE, 155 East 44th St., New York City.

LOCK JOINT REINFORCED CONCRETE PIPE

LOCK JOINT PIPE CO., Established 1905 AMPERE, N. J.

PRESSURE • SUBAQUEOUS • SEWER • CULVERT

WATER CONTROL EQUIPMENT

WRITE FOR THE CATALOGS ON THE EQUIPMENT IN WHICH YOU ARE INTERESTED

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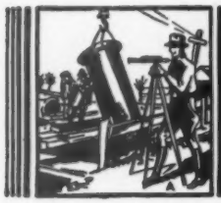

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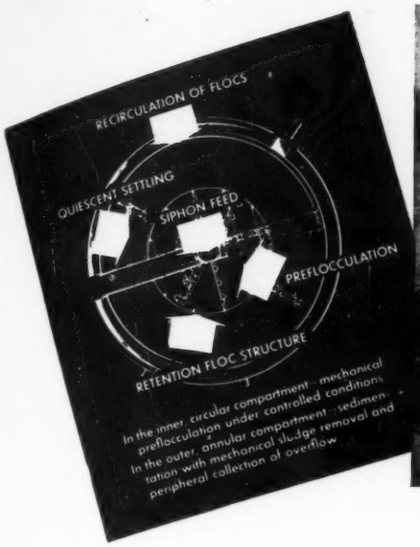
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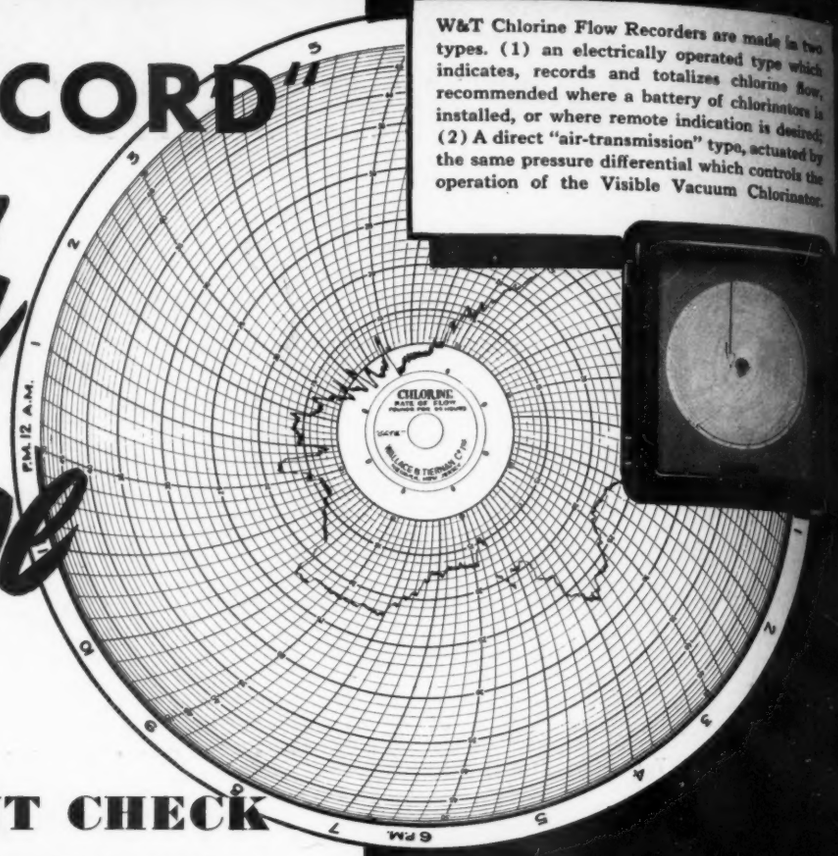

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